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Military Operations Research Society

70th MORSS Final Program & Book of Abstracts

Keynote Speaker

LTG Benjamin S. Griffin

Deputy Chief of Staff, G-8
US Army

70TH MORSS
FT. LEAVENWORTH 18-19-20 JUNE 2002
"Military Operations Research at the Next Frontier"

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Table of Contents

Table of Contents

Demonstrations/Exhibits

Other Special Events

General Information

Security Matters

Society Organization

Table of Contents

▸ ▸ ▸ ▸ Plenary Session ◂ ◂ ◂ ◂

Tuesday – 18 June 2002 - 0830 - 1000

Keynote Session & General Membership Meeting
Bell Hall, Eisenhower Auditorium

- **Call to Order**
  Dr. **Steven E. Pilnick**, Program Chair, 70th MORSS
- **National Anthem & Posting of Colors**
- **Host Welcome**
  Mr. **Michael F. Bauman**, Director, TRADOC Analysis Center
- **Sponsor's Welcome**
  Mr. **Walter W. Hollis**, FS, Deputy Under Secretary of the Army, Operations Research
- **Keynote Address**
  LTG **Benjamin S. Griffin**, Deputy Chief of Staff, G-8, US Army
- **MORS Welcome and 2002 Membership Meeting**
  Dr. **Thomas L. Allen**, President
- **Presentation of Awards – Dr. Thomas L. Allen**
  - Investing of Fellows of the Society (***Dr. Jerry A. Kotchka, Ms. Mary G.B. Pace & Mr. Vincent P. Roske, Jr.***)
    Dr. Thomas L. Allen, Lt Col Suzanne M. Beers, and Mr. Dean Free
  - Vance R. Wanner Award (***Mr. Michael F. Bauman***)
    Presented by Dr. Thomas L. Allen and Dr. Roy E. Rice
  - Clayton J. Thomas Award (***Dr. Gregory S. Parnell, FS***)
    Presented by Dr. Thomas L. Allen and Dr. Roy E. Rice
  - Richard H. Barchi Prize (***Mr. Branford J. McAllister***)
    Presented by Dr. Thomas L. Allen and Mr. Denis Clements
  - Announcement of MOR Journal Award
    (Presented at 5th Annual MAS Conference)
- **State of the Society** – Dr. **Thomas L. Allen**
- **Recognition of Chairs** – Dr. **Thomas L. Allen**
- **Administrative Announcements** – Mr. **Patrick Smock**

▶ ▶ ▶ ▶ ▶ Special Session I ◀ ◀ ◀ ◀ ◀

Tuesday - 18 June 2002 - 1530-1700

Special Sessions Coordinators: ***Sue Iwanski**, SPA, Inc*
***Bob Clemence**, RAND*

Barchi Prize Paper Session ....***GIF, DuPuy Auditorium***
Chair: ***Denis Clements**, GRCI*

MORS will recognize and present the Barchi Prize during the Plenary Session. The Barchi Prize is selected annually from among the papers derived from each working group's best presentation. Therefore, the Barchi Prize is often called "the Best of the Best." The author will brief his award-winning accomplishments during this Prize Paper Session.

70th MORSS Barchi Prize Recipient: *Col Branford J. McAllister*, USAF (Ret.), Sverdrup Technology Inc.

F-15/AIM-120 AMRAAM Weapons Envelopes: A Unique Application of Operations Research During Operational Testing

Air-to-air combat often is characterized by tradeoff decisions involving lethality and survivability. For example, the choices of radar mode and shooter maneuvers that are best for the success of a missile (lethality) place the shooter at greater risk to a successful engagement by his adversary (survivability). This paper documents the results of an operational test and evaluation (OT&E) assessing these tradeoffs using operations research tools. The test had two objectives: (1) assess the lethality of the AIM-120 air-to-air missile and the validity of F-15-computed envelopes and displays as a function of radar mode and shooter post-launch maneuvers, and (2) evaluate the effects of pot-launch maneuvering on survivability during air-to-air engagements. There were three noteworthy aspects of this evaluation. The use of Design of Experiment (DOE) and statistical techniques to plan the test, execute flight missions and simulations, and analyze results. The second was the marriage of open-air flight test and simulation models to obtain realistic and tactically sound test data. The third was a set of conclusions and recommendations pertaining to the tactical decisions (tradeoffs) regarding radar mode and shooter maneuvers, and the impact of those decisions on engagement success.

Junior/Senior Analyst Session 1 ....***Bell Hall, Marshall Auditorium***
Chair: ***Jay Wilmeth**, Northrop Grumman IT*

The Junior/Senior Analyst program will take place for the thirteenth consecutive year at the 70th MORS Symposium at the US Army Combined Arms Center at Fort Leavenworth, Kansas. Historically, this event has been very successful and has drawn both junior and mid-level audiences. MORS offers two separate sessions, each on consecutive days. The idea is to accommodate those who enjoy visiting with and listening to leading senior analysts known to most of us, while enabling our more junior analysts to focus on their concerns with mid-level, well established MORSians closely aligned with the analytical community of today.

The **first session** is scheduled for Tuesday afternoon in an auditorium that will accommodate a relatively large number of participants. The session will be open to all to hear distinguished senior analysts discuss topics relating to this year's theme in particular and to the world of operations research in general. After introductory remarks from each of the seniors, the balance of the period will feature a moderator-led Q&A session from the floor. This session was enormously successful last year at the Naval Academy. We hope to duplicate or surpass it this year.

Senior Analysts	
Mr. **Vincent P. Roske, Jr.**, FS, Joint Staff, J8	Dr. **Peter Purdue**, Naval Postgraduate School
Dr. **Alfred Brandstein**, Marine Corps Warfighting Lab	Dr. **Roy E. Rice**, Teledyne Brown Engineering

Homeland Security Special Session ....***Bell Hall, Eisenhower Auditorium***
Chair: ***LTC George F. Stone III**, USA, OSD(PA&E)*

When MORS held its first Homeland Security (HLS) Mini-Symposium in March of 2001, HLS interest was still developing. During the mini-symposium, the papers and discussions were very informative, yet the "fire and brimstone" effects of September 11th were unheard of. Now the words of Thomas Jefferson ring true: " It is our duty still to endeavor to avoid war; but if it shall actually take place, no matter by whom brought on, we must defend ourselves. If our house be on fire... we must try to extinguish it."

Suddenly the country realizes the vulnerability of the US homeland. The HLS vision and effort are now a main concern of our populace and at all levels of government. About 40 agencies will need to work together toward a common goal. Proponents who sought more emphasis on asymmetric warfare and HLS were included in the 2001 Quadrennial Defense Review: "Mr. Rumsfeld

said the QDR 'fortuitously ... at least addressed the problems of homeland defense and the problems of asymmetrical threats rather well.'" The supporting role that the military will play in the Office of Homeland Security is becoming a high priority mission.

The HLS office and supporting agencies will need analytical support for decision makers to prepare, train, equip and integrate personnel, efforts and resources.

If you are thinking about volunteering to work in Homeland Security, you are not alone:

- "...need to get a lot smarter about this HLS missioning (sic) in order to provide proper guidance to the staff when we develop OPORD/OPLAN."
- "I am working with the Navy staff (N70 CP) on homeland security issues. I am trying to track down any briefs, findings, articles, etc that came from this area."
- "How do I apply?"
- "I used to manage counter-terrorism training and presently own a chemical and biological decontamination company. I would like to become involved in homeland security. Is there someone you might recommend I contact?"
- "Can you tell me how one would go about applying for a position in the Homeland Security field? Would the FBI be a start? Thank you for any information you can send me. I live in San Diego, CA."
- "I would like to offer my expertise in moving individuals to collective action through communication campaigns. Could you please supply an address for the new Office of Homeland Security announced by President Bush last night?"

"While the attacks were horrible, [Sergeant Major of the Army] Tilley said he has noticed increased patriotism among all Americans, not just the military. He recounted how the day after the attacks a reserve soldier was getting gas for his car and when he went to pay, the attendant said it was on him as the soldier was helping to defend the country. He also said that he has been getting dozens of phone calls from retirees asking if they can come back to help without pay and asking how else they can help."

Although MORS will not pay for your gas to get to the 70th Military Operations Research Society Symposium at Fort Leavenworth in June 2002, we think that you may want to volunteer your time to this area. For the HLS Special Session, invited speakers will present their perspectives on Homeland Security and how the MORS community can contribute. Thank you in advance for highlighting this session on your 70th MORSS schedule. United we stand!

Workshop Reports I .... *Bell Hall, Classroom 2 (Arnold Conference Room)*
Analyzing Effects-Based Operations (EBO)

*Chairs: **Dr. Jackie Henningsen**, FS, HQ USAF and **MG Dean Cash**, J9/JFCOM*
*Technical Chairs: **Dr Dick Hayes**, EBR and Ms. **Sue Iwanski**, SPA*

Many of the organizations both inside and outside the DoD community are interested and involved in employing and analyzing Effects-Based Operations. The goal of this meeting was to provide an opportunity to bring people from those organizations together to share their work, develop a common view of the state of the practice, expose members of the broader analytic community to their needs, and identify shortfalls and potential solutions.

The objectives of this special meeting were to:

- Achieve an understanding of the analytical challenge of Effects-Based Operations
- Explore what tools, data, and metrics exist or need to be developed
- Relate the concept to what already exists.
-

The meeting started in a mini-symposium format to bring all participants up to speed on the state of the practice. This was followed by a two-day workshop where the participants met in working groups to further examine specific topics. Working group topics were: Decision Support for Operations, Decision Support for Force Structure Planning, Wargaming, Experimentation, and Exercises, Indicators of Success, Fundamental Sciences, and Effects Based Analysis for Counterterrorism. This Special Session out brief will provide a summation of this meeting, which was attended by 177 participants.

Operations Research Methods for Information Operations: A Battlespace of the 21st Century

*Chair: **Dr. Dick Deckro**, AFIT/ENS*

The objective of this workshop was to increase the awareness of the relationship between IO and OR and to enhance the integration of that relationship. An overview of IO was given the first day, stressing similarities and differences in joint and service perspectives on IO. Attendees then broke out into working groups: 1) MOEs/BDA for IO; 2) Intel/Decision Support Tools; 3) Critical Infrastructures and Defending Information; 4) Human Elements in IO; to work these issues. Finally, the presenters and attendees developed a set of IO/OR "challenges". The group ranked the top 10 challenges, outlining the needs and requirements for each.

This Special Session out brief will summarize the activities and findings of the workshop.

▶ ▶ ▶ ▶ ▶ Special Session II ◀ ◀ ◀ ◀ ◀

Wednesday – 19 June 2002 – 1530-1700

Countering Terrorism .... ***Bell Hall, Marshall Auditorium***

*Chair: Dr. **Bob Clemence**, RAND*

Terrorists have targeted the United States more than any other country. Several reasons for this phenomenon suggest that this attraction will continue. The geographic diversity of America's commercial interests abroad and the presence of its military bases in foreign countries provide a plethora of readily available targets. Any blow against the United States has enormous symbolic value, given its preeminent political, military, and economic stature. Lastly, any attack on an American target assures publicity and worldwide media exposure. While earlier terrorist acts against the United States did not threaten its basic way of life, the attacks on the World Trade Center and the Pentagon in September 2001 with their catastrophic consequences in loss of life, in property and in commerce have propelled terrorism to the forefront of American security concerns.

This session will host a panel discussion on the changing nature of terrorism and its implications for U.S. strategy. Panelists will include:

- Mr. Doug Schultz, IDA
- Mr. Mike Wermuth, ESQ, RAND
- LTC William Flynt, TRADOC
- Mr. Steven Moniz, TRAC

Workshop Reports II .... ***GIF, DuPuy Auditorium***

Analysis of Urban Warfare Workshop

*Chairs: **Ted Smyth**, Johns Hopkins University Applied Physics Laboratory*
*   **Greg Keethler**, Applied Research Associates, Inc.*

This Special Session will provide a summation of the Analysis of Urban Warfare Workshop, conducted at the Johns Hopkins University Applied Physics Laboratory, Laurel, MD, during the period of 2-4 October 2001. In keeping with this year's MORS' theme of supporting and reaching out to decision makers, the workshop focused on the following objectives:

- Gain an understanding of the basic characteristics, challenges and decision needs of current and anticipated joint urban combat operations.
- Assess the needs of decision makers.
- Perform an assessment of our knowledge, methods and existing data, relevant to joint urban combat operations.
- Provide a list of candidate actions necessary to acquire relevant knowledge and data and to develop appropriate analytical tools and methodologies in order to more effectively analyze and assess future warfighting concepts, operations, forces and systems employed in an urban environment.

Organizationally, the workshop was divided into both plenary and working group sessions with the intended purpose that the plenary session on 2 October and luncheon speakers would accomplish the first two objectives listed above. Working group sessions on 3 and 4 October, led by a distinguished group of MORSians, focused on specific areas that included: force packaging and projection; Intelligence, Reconnaissance and Surveillance (ISR); Command, Control and Communications (C3); force protection; application of force; mobility and maneuver; support and sustainment; and, synthesis/integration.

Significantly, the workshop marked the first time that issues pertaining to urban warfare have been addressed by MORS in over a decade. Results of the workshop, attended by 141 participants, will be presented.

Tackling the Space Community's Analytical Challenges

*Chair: LtCol **Suzanne Beers**, SMC Det 11/CWSN*

US Space Command combines Air Force, Army, and Navy space components to provide space-based support and combat capabilities to the warfighting Commanders-in-Chief. The support is currently focused predominantly in the areas of communication, navigation, meteorology, surveillance and reconnaissance. Although no current combat capabilities are provided directly from space, the future is ripe to exploit space for "gaining and maintaining the high ground". The MORS workshop "Tackling the Space Community's Analytical Challenges" focused on the space community's analytical challenges... surveyed current approaches, methodologies, models, tools and databases; identified gaps in the existing analytic capabilities; and proposed workable solutions to fill the gaps and support the needs of the warfighter. This Special Session outbrief will review the focus, objectives, and outcomes from each of the workshop's four working groups: analytical methods, analytical tools, operational methods, and sustainment methods

Junior/Senior Analyst Session II

*Chair: **Jay Wilmeth**, Northrop Grumman IT*

Session two will be dedicated exclusively to the junior analyst. We define junior analyst as one who is relatively new to the Military Operations Research world and will benefit from the wisdom provided by those more seasoned analysts who have "been around." It will follow a format that has been successful in the past. There will be four meeting rooms separated along Service and Joint duty lines featuring mid-level experienced analysts who are familiar with the day-to-day problems and issues facing the OR community today. The sessions will feature one or two seniors, each of whom will address the concerns of the attendees. It is envisioned that the questions and discussions will focus on career paths within the Military OR world and other "hot" topics important to junior analysts. It is at this second session that junior analysts will have the opportunity to meet with those more experienced analysts who are currently making significant contributions to military analysis and national security issues. We emphasize that, while all are welcome, the focus will be on the junior analyst during the Wednesday sessions. If last year was any indication, the sessions should feature no-holds-barred discussions and lively interchanges.

Senior Participants			
Room	**Senior Analyst**	**Room**	**Senior Analyst**
Army GIF 253A	**Dr. Andy Loerch**, GMU **COL Jeff Appleget**, TRAC-WSMR	Air Force GIF 253B	**Mr. Gary Engel**, Boeing
Naval GIF 253C	**Mr. Dennis Baer**, Northrop Grumman IT **Dr. George Akst**, MCCDC	JS/OSD GIF 253D	**Ms. Anne Patenaude**, Northrop Grumman IT **COL Ed Cardenas**, US CENTCOM

▶ ▶ ▶ ▶ ▶ Special Session III ◀ ◀ ◀ ◀ ◀

Thursday – 20 June 2002 – 1530-1700

Transforming U.S. Forces For The Future .... *Bell Hall, Marshall Auditorium*

*Chair: **Dr. Bob Clemence**, RAND*

Accelerating the transformation of the U.S. military forces is a major theme of the new administration's defense strategy. Military transformation is distinctly different from modernization. While modernization replaces or upgrades existing materiel inventories, transformation evolves and deploys new combat capabilities that provide revolutionary advantages over adversaries. The Department of Defense has articulated an ambitious transformation vision in Joint Vision 2020 and all military service branches have established transformation roadmaps and activities, including wargames, battle labs/concept development efforts, and experimentation.

This session will host a panel discussion of the transformation activities of the Army, the Navy, the Air Force and the Marine Corps. The aim of the discussion will be to identify the objectives and desired capabilities of transformation, the current service schedules, inter-service dependencies and co-ordination, as well as the tradeoffs each is making to accelerate the process.

Panelists	
Army	COL Bruce Jette, Army Objective Task Force
Navy	CAPT Bill Hoker, N81X
Air Force	Col Richard Smith, AFSAA
Marines	COL Arthur Corbett

Heritage Session .... *Bell Hall, Classroom 2 (Arnold Conference Room)*

*Chairs: **Mike Garrambone**, Veridian; **Eugene Visco**, FS*

It has become a tradition of the Military Operations Research Society's Symposia that there be a Heritage Session, identifying the history of military operational analysis particularly relevant to the specific symposium. The 70th MORSS will continue that tradition.

Speakers: Dr. **Warren K. Olson** "Reflections on a Career in Operations Research" and Mr. **Arend H. "Pete" Reid** "Origins of Systems Analysis at Aberdeen Proving Ground."

▶ ▶ ▶ ▶ ▶ ▶ ▶ Tutorials ◀ ◀ ◀ ◀ ◀ ◀ ◀

Tue, Wed, Thurs – Luncheon Tutorials – 18, 19, 20 June 2002 – 1215-1315

Coordinator: ***Dr. Andrew Loerch**, GMU*

Tutorial On Step #1 Of The Scientific Method: How To Define A Problem ....*Tuesday, GIF, DuPuy Auditorium*

***Roy E. Rice**, Ph.D., Teledyne Brown Engineering*

This tutorial is intended to teach a repeatable process for accomplishing the first step in the Scientific Method – defining the problem. This is the most crucial step in beginning any analysis or study. Not defining the problem correctly will ensure that the study will fail to meet the customer's expectation. The best analysis performed on the wrong problem results in wasted resources and a frustrated decision maker. Many of our educational institutions do a tremendous job of teaching the analytical methods and tools used in executing an analysis. However, our educational efforts do little to teach our young analysts how to adequately define the problem. This tutorial focuses on involving the decision maker, a methodical approach (template) for describing the problem, and the context in which it is used in the analysis process. The intended audience is the beginning analyst and the analysis agency's managers who must train the analyst in the art of problem solving.

Spreadsheet Analysis ....*Tuesday & Wednesday, Bell Hall, Marshall Auditorium*

*CDR **Matt Boensel**, Department of Operations Research, Naval Postgraduate School*

A popular general-purpose spreadsheet program such as Microsoft ® Excel is widely available to analysts everywhere, and may be the only analysis tool available in many military operational commands. However, spreadsheets are typically less used in OR graduate programs than more specialized statistics, simulation, or optimization software packages. We highlight some of the OR methods which are amenable to spreadsheet application and some which are not, and demonstrate a few advanced capabilities within spreadsheets (e.g. simulation). This tutorial is based on a capstone course taught at NPS, in which we tie together the concepts and techniques learned in the Operations Analysis curriculum (using specialized software packages) into a set of tools that the officer-students can apply in any setting. While the content of the course is accessible to students with limited foreknowledge, the significance of determining which techniques can be appropriately implemented on the spreadsheets cannot be understated.

Top Ten Secrets for Successful Application of Optimization..................................*Wednesday, GIF, DuPuy Auditorium*

*Dr. **Gerald G. Brown**, Distinguished Professor of Operations Research, Naval Postgraduate School*

There are some key differences between a textbook optimization model and the real thing. Models that have any chance of succeeding on their own in the real world have features that textbooks don't mention. This is too bad, because without these essentials a model has scant chance of seeing real-life application by anyone but its original developers. Recent DoD case studies show examples of the most valuable model features that are most often neglected.

Dr. Gerald G. Brown is Distinguished Professor of Operations Research at the Naval Postgraduate School, where he has taught and conducted basic and applied research in optimization theory and optimization-based decision support since 1973. His military research has been applied by every uniformed service, in areas ranging from strategic nuclear targeting to capital budgeting. He has been awarded the Rist Prize for military operations research. He has designed and implemented decision support software currently used by two-thirds of the Fortune 50, in areas ranging from vehicle routing to supply chain optimization. His research appears in scores of open-literature publications and classified reports, many of which are seminal references in the field. He has earned long-term basic research support from the Air Force Office of Scientific Research, and the Office of Naval Research.

Complex Adaptive Systems and Agent Modeling for Military Analysis ....*Thursday, Bell Hall, Marshall Auditorium*

*Lt Col **Raymond R. Hill** and Capt **Lance Champagne**, Department of Operational Sciences, Air Force Institute of Technology*

An interesting area of research, both theoretical and applied, is the "new sciences" which encompass topics such as chaos and complexity, complex adaptive systems and artificial life. The military analytical community has become increasingly interested in these sciences evidenced by recent mini-symposiums and the special issue in ***Military Operations Research***, and the increasing number of presentations at the Military Operations Research Society Symposia. This interest should not be construed as passing fancy; at least we should hope not. Rather, this interest should be viewed as an opportunity to improve our abilities to analyze, model, and understand warfare.

Agent modeling and complex adaptive systems promise a new modeling paradigm for military simulation. Combat is widely recognized as a chaotic system where various intangibles, such as leadership, are often the keys to success in the battles and ultimately the war. Conversely, failure on the battlefield is not always due to overwhelming force. Military incompetence is most expensive when manifest among the military leadership. The promise of agent modeling for military modeling is its seeming ability to bring the cognitive role of leadership into the military model. Software agent technology is well capable of providing situational assessment functions, information fusion abilities, and various rule-based behaviors. However, achieving true cognition in a software agent is still an unrealized dream.

The challenge is determining where agent modeling can assist military modeling, how this technology will provide that help, and determining the technical challenges that remain to fully realize the promise of agents in military modeling particularly as agent technology is applied to models higher.

In this tutorial we cover some of the underlying concepts of chaos and complexity. We then discuss some uses and applications of cellular automata models and agent based models particularly as applied to military problems. During these overviews we discuss some of the challenges associated with agent models particularly in the analysis of output data. We also provide an update on military-related research efforts in CAS and agent-modeling to include the Defense Modeling and Simulation Office sponsored Bay of Biscay study.

Poster Session and Job Fair

▸ ▸ ▸ ▸ ▸ Poster Session ◂ ◂ ◂ ◂ ◂

All day Tuesday & Wednesday – 18 - 19 June 2002
GIF, First Floor Lobby

Coordinator: ***Sherry Barnes**, sbarnes@jwac.osis.gov*

The 70th MORSS Poster Session will be on continuous display in the General Instruction Facility (GIF) on Tuesday and Wednesday (18-19 June 2002). This venue will provide both viewers and presenters opportunities to meet, view and discuss presentations.

Hard and Deeply Buried Target Defeat Capability Analysis of Alternatives Lethality Approach

Kara J. Peterson, **Frank A. Maastes** , **John C. Galloway**, Applied Research Assoc, Inc (ARA), **Richard Freet**, HQ ACC/XRYF and **Maj Michael Hockenberger**, HQ ACC/XRMA

The Hard and Deeply Buried Target Defeat Capability (HDBTDC) Analysis of Alternatives (AOA) was a tri-service effort led by the Air Force Air Combat Command (ACC) and Air Force Space Command (AFSPC) to determine the best weapon system solution for the defeat of hard and deeply buried targets. This paper describes the methodology and approach used for the lethality analysis portion of the HDBTDC AOA.

The HDBTDC AOA was performed in three steps. Under Step 1, measures of performance and measures of effectiveness were defined. In addition, representative hard targets were chosen for the template target set and defeat mechanisms were defined for each template target based on the target function and the amount of intelligence data available on the specific target. In Step 2, a screening analysis was completed that used simplified algorithms to analyze the effectiveness of the conceptual weapon systems against the template target set. The weapon system concepts were then compared within categories to select the most promising candidates for additional analysis. Based on this comparison, generic weapons were designed to improve performance in each category. In Step 3 a detailed analysis was completed in which the best systems in each category from Step 2 and the generic weapon concepts were evaluated in more detail using the Modular Effectiveness and Vulnerability Assessment (MEVA) code. Step 3 also included an excursion analysis that tested the robustness of weapon system concepts against targets for which there is uncertainty in physical and functional definition.

▸ ▸ ▸ ▸ ▸ Sponsors' Job Fair ◂ ◂ ◂ ◂ ◂

Bell Hall – Trophy Lounge

Coordinator: ***Corinne Wallshein**, Corinne.wallshein@pentagon.af.mil*

What: 70th MORSS Sponsors' Job Fair for Civilian Operations Research Analysts

When: Tuesday from 1530 to 1700
Wednesday from 1230 to 1430
Thursday from 0830 to 1030

Where: Bell Hall, Trophy Lounge

How & Who: Learn about Civilian Operations Research Analyst opportunities and upcoming vacancies in DOD analysis organizations. If you are interested in Federal employment, come look at what's out there, see what may be opening in the future and chart the Next Frontier in your career. Sponsors with immediate and planned job vacancies will provide a representative to discuss these opportunities with you. Sign up sheets will be available in the Trophy Room for private sessions to discuss specific vacancies. For those sessions, bring your resume to leave with the sponsor's representative.

▶ ▶ ▶ Composite Groups ◀ ◀ ◀

COMPOSITE GROUP	DATE/TIME	*TITLE*	AUTHOR	ROOM
A	Tuesday 18 June **1330 – 1500**	*CBRNE Hazard Analysis*	LTC **Debra Schnelle**, Office of The Surgeon General	GIF, DuPuy Auditorium
		Weapons of Mass Destruction – Impact on Army Operations	MAJ **Jon Payne**, CAA	
B	Tuesday 18 June **1330 – 1500**	*Al Qaeda and the "Imposed Symmetry Model"*	Dr. **George Friedman**	Bell Hall, Marshall Auditorium
C	Wednesday 19 June **0830 – 1000**	*Metrics for Transformation*	**Cynthia Dion-Schwarz** Institute for Defense Analyses	Bell Hall, Marshall Auditorium
		JWARS History and Insights	**Jim Metzger**, JWARS	
D	Wednesday 19 June **1330 - 1500**	*Developing Aerospace Leaders Overview*	Maj Gen **Chuck Link** (USAF retired)	Bell Hall, Marshall Auditorium
			Brig Gen **Richard S. Hassan**, USAF	
			Lt Col **Jennifer L. Graham**, USAF	
E	Wednesday 19 June **1030 - 1200**	*Strategic Plan for Transforming DoD's Training*	**Daniel E. Gardner**, OSD	Bell Hall, Marshall Auditorium
F	Wednesday 19 June **1330 – 1500**	*Measuring the Value of Prewar C4I, and Costing the Contribution of C4I to the Weapon System*	**Joseph F. Auletta**, AFMC OAS/DR	GIF, DuPuy Auditorium
		Measures of Effectiveness Applied to Joint Combat Identification	**Joel R. Parker**, MEVATEC Corp.	

Composite Group A — Strategic & Defense

Working Groups 1, 2, 3, 4
Chair: Julia Klare Burr, IDA
Co-chairs: Debbie Lott, Center for Army Analyses
Tom Pendergast, Modern Technology Solutions
Advisor: William Beardon, Los Alamos National Laboratory

Tuesday-18 June-1330-1500
GIF, DuPuy Auditorium

CBRNE Hazard Analysis

LTC Debra Schnelle
Medical NBC Staff Officer
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The spectrum of CBRNE threats is highly varied and almost unlimited in scope, ranging from contamination of food supplies to attacks against industrial chemical facilities to large scale aerosol releases of biological agent or detonation of nuclear devices. In these circumstances, threat-based planning--identifying every possible threat and planning appropriate actions to mitigate them--is likely to be a futile undertaking, in that any such effort may well overlook the threat that ultimately materializes, and leave us unprepared to manage the consequences.

As an alternative, the CBRNE Hazard Analysis now being sponsored by the US Army Office of the Surgeon General (OTSG) seeks to lay the foundation for a shift from threat-based to capability-based planning in the medical arena. This approach uses modeling and simulation tools to characterize the impact of CBRNE hazards and requirements, here defined in terms of scale of prospective casualties and resources required to treat them. By assessing hazards based on their consequences, rather than their individual characteristics, OTSG hopes to generate a common basis for understanding CBRNE hazards within the military and civilian medical communities, which can then be used to prioritize efforts and resources devoted to generating the capabilities to respond to them.

Weapons of Mass Destruction -- Impact on Army Operations

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Recent WMD studies have focused on the effects at specific nodes during force projection or during offensive/defensive operations in-theater. These studies are stand-alone and not linked to provide a comprehensive assessment of the effects on the Army across the spectrum of operations and across lines of communication. This study examined previous studies to determine: Army WMD vulnerabilities during the Mobility, Deployment and Employment phases of Force Projection; planning guidance to reduce impact on operations by threat use of WMD to deny or limit LOCs; provide insights and recommendations for changes in WMD defense to reduce vulnerabilities. Analysis methodology is described and results are shown.

Composite Group B — Space/C4ISR

Working Groups 5, 6, 7, 8, 9, 10, 11
Chair: Dr. Ted Bennett, Naval Oceanographic Office
Tuesday-18 June-1330-1500
Bell Hall, Marshall Auditorium

Al Qaeda and the "Imposed Symmetry Model"

Dr. George Friedman
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The problem of al Qaeda has posed a unique challenge to U.S. war fighting practices. The logical hierarchy of U.S. warfighting doctrine ranges from global, high intensity conflict against symmetric forces down to localized, low intensity conflict against asymmetric forces. Al Qaeda confounds this model by posing a global, low intensity challenge from a sparse and diffuse network of operatives. This has created a conceptual challenge for the United States. The combination of a global challenge against a sparse, irregular force is not only difficult to conceptualize it is also extremely difficult to model. The enemy contains too few pieces with too many options for prediction. This was the problem faced by Israel during the latest wave of suicide bombings. Israel's solution was to decline combat on the terms being set by the Palestinians and convert the war into a warfighting paradigm that was suited to Israeli needs. While there are many differences, on the highest level, the Israeli model is one that the United States is clearly examining on a global basis and which must be examined by the simulation and modeling community. We will call this the "imposed symmetry" model of warfare.

Composite Group C — Joint Warfare

Working Groups 12, 13, 14, 15, 16, 17
Chair: Robert C. Holcomb, Institute for Defense Analyses
Wednesday-19 June-0830-1000
Bell Hall, Marshall Auditorium

Metrics for Transformation

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The 2001 Quadrennial Defense Review identifies six operational goals as the focus for the DoD's immediate transformation efforts. In this paper, we discuss the framework for thinking about the six goals. This framework recognizes that three of the goals (Assure Information Systems, Enhanced Space Systems and Leverage Information Technology) can be thought of as leading to Decision Superiority, and enabling new ways to fight, especially in the Joint arena. The other three goals (Protecting Bases of Operations, Force Projection in Anti-Access Environments and Deny Enemies Sanctuary) can be seen as more traditional operational goals that are transformational when performance is greatly extended beyond current capabilities.

For each of the six goals, enabling capabilities were identified that are key to achieving transformational capabilities, along with metrics that could be used to measure progress. We give examples of metrics for these enabling capabilities that can be used to understand progress toward transformation. Lastly, we discuss how the metrics can be used to advance transformation by analyzing an investment strategy, by providing guidance on gaps, and by measuring near-term progress.

JWARS History and Insights

Jim Metzger
Director, JWARS Office, 1555 Wilson Blvd, #620, Arlington VA 22209-2405
703-696-9490 FAX 703-696-9563, jim.Metzger@osd.pentagon.mil

This presentation is a management-oriented review of the Joint Warfare System (JWARS) development project. JWARS is a theater-level warfare simulation being developed to support Department of Defense decision making. The presentation describes the history of the program – from inception in 1995 through the present – as well as its status. All aspects of development are covered, including management oversight, requirements, infrastructure, technical approach, development team, data, and user participation. The presentation concludes with insights.

Composite Group D — Resources

Working Groups 18, 19, 20
Chair: Herb Shukiar, RAND

Wednesday-19 June-1330-1500
Bell Hall, Marshall Auditorium

Developing Aerospace Leaders Overview

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2211 Jefferson Davis Hwy
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The Developing Aerospace Leaders (DAL) program was initiated by directive of the Air Force Chief of Staff to develop and implement deliberate leadership processes for the Total Force. The objective of this initiative is to ensure that Air Force officers, civilians and enlisted members have the competencies needed to operate in the battle space of the future. Competencies include skills, knowledge, and abilities related to specific occupations, as well as universal characteristics considered desirable regardless of a member's occupation. The DAL construct focuses on ensuring that required competencies for each position are instilled, through training, education, and/or experience, throughout the entire Air Force.

The DAL initiative started as a study in the July '99 timeframe and has evolved into a recognized part of the institution and a formal DAL Support Office has been established within the Air Staff.

Composite Group E — Readiness/Training

Working Groups 21, 22, 23
Chair: LTC Greg McIntyre, JWARS Program Office

Wednesday-19 June-1030-1200
Bell Hall, Marshall Auditorium

Strategic Plan for Transforming DoD's Training

Dan Gardner
OSD Readiness & Training

The 2001 Quadrennial Defense Review recognized transformed training would be a key enabler toward achieving the operational goals of the overarching Transformation of the Department of Defense. The Defense Planning Guidance for FY 2003-07 directed the Under Secretary of Defense for Personnel and Readiness (USD (P&R)) to work with the Secretaries of the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commander of US Joint Forces Command, and Under Secretary of Defense for Acquisition Technology and Logistics to develop a strategic plan to transform military training to better enable Joint Force operations. A defense-wide collaborative effort was undertaken to develop a requested Strategy Plan, a vision, goals, and road map for implementation. A four-star Executive Steering Group chaired by the USD(P&R), Dr. David Chu, and a three and two-star Senior Advisory Group, chaired by the Deputy Under Secretary of Defense for Readiness, Dr. Paul Mayberry, were established with a Training Transformation Integrated Process Team of senior level analysts, planners, and action officers for support. These groups collectively developed the strategic plan and submitted it to the Secretary of Defense on 1 March.

Composite Group F — Acquisition

Chair: John Ferguson (Northrop Grumman Information Technology)
Co-chair: Harlan Loomis (MITRE)
Advisor: Mike Lavine (MITRE)

Wednesday-19 June-1330-1500
GIF, DuPuy Auditorium

Measuring the Value of Prewar C4I, and Costing the Contribution of C4I to the Weapon System

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The nature of major Air Force system acquisitions is substantially changing. The systems themselves are much more information dependent, and many of the Analyses of Alternatives (AoA's) for these acquisition systems must address a trade of money spent on information vs. money spent on warhead. This presentation will focus upon several significant steps the Air Force has taken to improve how it analyzes the value of information in AOA's, some still-needed improvements, and some problem areas, as we continue to adapt the AoA process for C4I systems. The specific areas of discussion include how to cost C4I support to a weapon system and how to measure the "value" of C4I in a pre-war environment.

Measures of Effectiveness Applied to Joint Combat Identification

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Emerging requirements within DoD now challenge the newly designated Joint Combat Identification and Evaluation Team (JCIET) Command as it looks to plan future evaluations. These emerging requirements are (1) The conduct of CID evaluations within established joint exercises; and, (2) Evaluations of the Key Performance Parameters (KPPs) stated in the newly approved Combat Identification (CID) Capstone Requirements Document (CRD).

The JCIET Command serves as a joint activity under the command & control of the Joint Forces Command (JFCOM) to evaluate the joint mission area of Combat Identification (CID). The objective of Command participation in the 2002 Military Operations Research Society Symposium (MORSS) is to interact, through an information presentation, with the MORS community. This proposed interaction would focus on emerging requirements driving Measure of Effectiveness (MOE) refinements/developments for the Command. The scope of the presentation would be limited to the practical use of MOEs for root-cause analysis in evaluating the formal joint Mission Area of Combat Identification.

Root-cause analysis does not employ statistical techniques. The Command is largely limited to this method of analysis because of the employed method for collecting data. All data is collected during an evaluation conducted over a two-week period within a live, dynamic joint environment allowing the prosecution of free play operations. Collected data allows detailed mission reconstruction and supports rigorous analysis of evaluation objectives.

JCIET Operations are joint in nature and comprise joint task force resources. Such operations employ select land, sea and air weapons platforms, staffs and forces across all of the Services. These resources are "networked" with Command and Control (C2) and Intelligence, Surveillance and Reconnaissance (ISR) systems. ISR systems include all levels of conflict, i.e. National Technical Means (NTM), operational and tactical. "Networking" consists of existing or developmental tactical data networks.

The JCIET Command welcomes the opportunity to provide an information presentation to interested members of the MORSS community regarding refinements and use of established MOEs to assist root-cause analysis associated with these two emerging requirements.

▸ ▸ ▸ ▸ Demonstrations ◂ ◂ ◂ ◂

All day Tuesday & Wednesday – 18 - 19 June 2002
Thursday – 20 June 2002– 0830-1200

Coordinator: ***Bill Dunn,*** *IITRI*

Synthetic Theater Operations Research Model (STORM) Demonstration...............GIF Room 254D

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STORM, the U.S. Air Force's next-generation campaign analysis model, is due for operational release in December 2002. As a follow-on to the current model, Thunder, STORM represents the USAF's contribution to next-generation, theater, campaign analysis with representation of air and space power in a Joint context while incorporating flexible design philosophy, innovative OO structures, and beginning-to-end analysis support. The STORM development mission is to provide USAF analysts with a high-quality, DoD-compliant campaign analysis capability possessing believable representations of warfighting activities and functional user interfaces.

STORM represents a new approach in analytic simulation utility with a maximum use of freeware/GOTS software (GNU compiler, MySQL database, MS Office™ tools, Oilstock Mapping, *et al*) and multi-platform compatibility (currently SUN-Solaris, PC-Linux, with PC-NT in progress). The Common Analysis Simulation Architecture (CASA) is an OO, C++ framework designed to link simulations to database mechanisms, input interfaces, and output visualization and analysis tools. STORM is currently one of two Air Force simulations to take advantage of CASA and has been readily linked to three database mechanisms and five visualization packages in as little as one day for installation. This highly reconfigurable approach to analytic systems allows users to define their own custom analysis tool suite with the goal of significantly reducing life cycle costs.

Joint Warfare System (JWARS) Overview and Demo.......................................GIF Room 358C

Dr. Jim Metzger, Director
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The Joint Warfare System (JWARS) will be a state-of-the-art, closed-form constructive simulation that will provide a multi-sided and balanced representation of joint theater warfare. Users of JWARS will include the Combatant Commanders, Joint Staff, Services, Office of Secretary of Defense (OSD), and other DoD organizations. JWARS will be capable of performing Courses of Action and Force Sufficiency analyses at its Full IOC, and will be able to System Effectiveness Analyses and Trade-off analysis and Concept and Doctrine Development at its FOC.

This Presentation will provide an overview and demonstration of the JWARS project. It will provide a discussion on the background of JWARS, how oversight of the program is conducted, an overview of the requirements process, some of the development techniques, and a quick look at the evaluation process. It will also include a Video-Playback Demonstration of JWARS functionality.

Joint Modeling and Simulation System (JMASS) Putting Flesh on the Reuse Efficiency Bones! ....GIF, Room 358D

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In previous papers, the author revealed what JMASS is, does implies and means, establishing how this object-oriented, paradigm-shifting, digital, constructive, engagement-level modeling and simulation (M&S) architecture offers remarkable software reuse efficiencies, and at the same time seriously challenges the DoD to realize those efficiencies. In this paper, the author focuses on a specific JMASS application area – aircraft combat survivability – and lays out a process and an infrastructure to meet this challenge and bring the M&S reuse bugaboo to its knees. Key to this process for JMASS-based survivability M&S tools is maximal leveraging of the best features of the existing processes, e.g., using established relationships and time-proven configuration management and software maintenance approaches, Key to the infrastructure which must needs exist to support this process is once again maximal leveraging of existing management structures, e.g., refining application-specific user groups to reflect the new, JMASS way of crafting M&S solutions to survivability community problems. Key to both this process and infrastructure is a mechanism for documenting in an understandable and meaningful way the requirements for and capabilities inherent in the JMASS paradigm. This paper concludes by proposing a three-dimensional fabric, woven of process, infrastructure and mechanism, and offering the realization of these reuse efficiencies for the aircraft combat survivability community.

NBC Casualty and Resource Estimation Support Tool (NBC CREST)........GIF 254A

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The Nuclear, Biological, and Chemical Casualty Resource Estimation Support Tool (NBC CREST) supports deliberate medical planning in an iterative, integrated process for US Army medical planning at the Corps, Division, and Corps Medical Brigade levels.

NBC CREST provides an analysis capability designed to estimate the potential for casualties, medical requirements, available resources, and evaluate alternative medical courses of action in the NBC environment. The tool provides casualty estimation based on a user-defined NBC scenario, detailing the deployment and defensive posture of combat personnel and rear area personnel together on a map-based graphical user interface. NBC casualty scenarios may be developed in accordance with current threat assessments and planning guidance. Based on the resulting patient stream, the tool provides a time-phased estimate of the required medical resources for patient treatment and an analysis of potential medical courses of action for an assessment of medical resource sufficiency based on the deployed medical support network.

The capability of deployed medical resources to meet demand is analyzed and the results are displayed. Depending on the required level of resource satisfaction and detail required, the user may iteratively modify existing deployed medical resources down to the unit level to resolve potential resource shortfalls, or evaluate the benefits of additional medical support during the planning stages of a mission. Subsequent analyses will show how well the new medical Course Of Action resource set satisfies the requirements.

A comparison of two or more medical courses of action based on Deployment, Disposition, and Utilization (DDU) criteria assist the user in identifying the optimal medical course of action, where the lowest rank indicates the best overall performance. The NBC CREST prototype Version 2.1 was developed in conjunction with the Army Office of the Surgeon General.

Other Special Events

Other Special Events

DATE/TIME	EVENT	COORDINATOR	ROOM
Tuesday 18 June 0715 – 0815	Working and Composite Group Warm-up	Mr. Jack Keane	Bell Hall Marshall Auditorium
Tuesday 18 June 1530 – 1700	Sponsors' Job Fair for Civilian OR Analysts	Ms. Corinne Wallshein	Bell Hall Trophy Lounge
Wednesday 19 June 0700 - 0800	Town Hall Breakfast Meeting (WG & CG Chairs ONLY)	Mr. Jack Keane	Hearth Room, FCC
	PHALANX Editors' Breakfast Meeting	Mr. Paul West	Centennial Room, FCC
	Military Operations Research Journal Editors' Breakfast Meeting	Dr. Dick Deckro	Porch Room, FCC
Wednesday 19 June 1230 – 1430	Sponsors' Job Fair for Civilian OR Analysts	Ms. Corinne Wallshein	Bell Hall Trophy Lounge
Thursday 20 June 0715 – 0815	Test & Evaluation, Modeling & Simulation & VV&A Workshop Organizing Committee Meeting	Ms. Anne Patenaude	Bell Hall CR6
Thursday 20 June 0830 – 1030	Sponsors' Job Fair for Civilian OR Analysts	Ms. Corinne Wallshein	Bell Hall Trophy Lounge
Thursday 20 June 1030-1145	71st MORSS Program Committee Meeting	Mr. Patrick McKenna	GIF, Room 253D
Thursday 20 June 1530-1700	Working and Composite Group Wrap-Up	Mr. Jack Keane	Bell Hall CR6

General Information

MORS Office at Fort Leavenworth

MORS office at Fort Leavenworth will be located in **Classroom 4A, Bell Hall**, USACGSC, and will open on Thursday and Friday, 13 and 14 June, and Monday, 17 June, 0830-1700; on 18, 19, 20 June, 0700-1730.

Phone numbers at FLVN:

913-684-7721

FAX **913-684-7723**

913-684-7722

DSN **552-**

PHONE ROOM

Phones with DSN lines and credit card capability will be available in Bell Hall, Classroom 4B.

Bus Transportation

Buses will transport attendees to Fort Leavenworth from the hotels listed below in the morning and back after the sessions each day and the mixer on Tuesday. Buses will also transport attendees from these hotels to and from the Wednesday evening at the Steamboat Arabia Museum Dinner. A detailed bus schedule is in the green section of this Final Program. ***Please note:*** *Due to increased post security, we strongly encourage all attendees to use the MORS buses.*

MORSS Hotels

The following are the hotels to and from which MORS will provide bus service. Please note that the MORS HQ Hotel is the AmeriSuites.

Hotel	Phone	# of Rooms	Rate
MORS HQ Hotel **AmeriSuites** 7600 NW 97th Terrace, Kansas City, MO 64153	816-891-0871	125	$85 + tax
MainStay Suites 9701 North Shannon Avenue, Kansas City, MO 64153-1828	816-891-8500	20	$59.95 + tax
Hilton KCI 8801 NW 112th Street, Kansas City, MO 64153	816-891-8900	75	$85/95 + tax
Radisson Hotel 11828 NW Plaza Circle, Kansas City, MO 64153	816-464-2423	100	$85 + tax
Holiday Inn KCI 11832 Plaza Circle, Kansas City, MO 64153	816-464-2345	85	$85 + tax
Fairfield Inn KCI 11820 NW Plaza Circle, Kansas City, MO 64153	816-464-2424	85	$72 + tax
Kansas City Airport Marriott 775 Brasilia Avenue, Kansas City, MO 64153	816-464-2200	50	$85/85 + 12.35 tax

MORSS Wednesday Night Event

The Wednesday night dinner activity will feature both a remarkable venue and world famous cuisine – Kansas City style barbeque. The venue will be the Steamboat Arabia Museum, which is located in the Kansas City, MO City Market Area. The address is 400 Grand Boulevard between 5th and 3rd Streets. The phone number is 816-471-1856. Dinner is being catered by Kansas City Masterpiece Barbeque and Grill! Bus transportation will be available to and from the dinner.

General Information

MORSS Registration

Regular Registration – Regular registration will take place on Tuesday, 18 June 2002, 0700-0900 on the Porch of Bell Hall.

1. Be sure to bring your yellow two-part Invitation with you to registration. The top part, Copy 1 Invitation/ Receipt is your copy. The bottom part, Copy 2, is MORS' copy. Please sign in on the bottom line before you arrive at registration.
2. At registration, you will be directed to the proper alphabetical line to register. The registrar will compare the MORS ID card with your features, and will ask for another picture ID. If all is in order, the registrar will keep Copy 2 and give you a package containing:
    a. Badge Holder with Name Badge and MORS ID Card (or place for active duty ID Card).
    b. MORSS Final Program and Book of Abstracts
    c. Membership Card
    d. Ticket(s) for any meals purchased
    e. Neck Chain
    f. MORSS Quick Reference Program Schedule (QRPS)

Those arriving after 0900 on Tuesday morning will register in the MORS Office (Bell Hall, Room 4A) at Fort Leavenworth.

Government Quarters – Government quarters and messing WILL NOT BE AVAILABLE. To accommodate this constraint, orders should specify Kansas City, Missouri as the TDY destination, with the following disclaimer provided in Block 16 of DD Form 1610: ***"Government mess/lodging are unavailable. Use of government facilities would adversely affect the performance of the assigned mission."***

Statements of Non-availability – Statements of Non-availability will NOT be provided; however, a non-availability number will be provided to attendees during registration so that it may be cited when applying for reimbursement after the symposium.

Lost/Found – The Lost and Found will be in the MORS office at the host facility. Items not claimed at the end of the Symposium will be left with the host facility.

Weather – The weather in June should be sunny and in the 80's during the day.

Uniform – If you are a military officer on active duty and would like to use your green active duty military ID card for photo identification at the symposium you MUST be in uniform. If you would prefer to use civilian attire then you must be issued a MORS ID card. Appropriate civilian attire is business casual.

Mixer – There will be an informal mixer at the Frontier Army Museum on Tuesday evening, 18 June, from 1715-1900. There will be a cash bar. Bus transportation will be provided back to the hotels before and after the mixer.

Lunches – There will be a lunch buffet at the Frontier Conference Center. Tickets are $7.00 per day and can be purchased in the MORS Office. Transportation will be provided to and from this facility. The following facilities are within walking distance: The General Instruction Facility (GIF) Cafeteria, Bell Hall Cafeteria, Trails West Golf Course Snack Bar, Burger King, and the Bowling Alley Snack Bar. Many restaurants and fast food facilities are located outside the main gate.

Box lunches – Box lunches are $8.00 each per day. Please purchase tickets in the MORS Office.

Coffee – Coffee and snacks will be provided on Tuesday, Wednesday and Thursday without charge at the following times:

0700-0830	1000-1030	1500-1530

Designated Smoking Areas – Smoking is NOT permitted in any building at Fort Leavenworth. Designated smoking areas will be posted.

Limo Service from the Airport – For limousine service to and from Kansas City International Airport (KCI) you can call ***#1 Limo Service***. Reservations: 913-208-6811, Email: namal@swbell.net, Website: www.1-limo.com. Reservations may be booked up to one year in advance. AmEx, MC/VISA and cash accepted.

▸ ▸ MORSS Security Matters ◂ ◂

All attendees and speakers at the 70th MORSS are US Nationals
All have SECRET clearances and need-to-know certified by competent authority.

Attendees are reminded of the necessity for continuing attention to security precautions. While every effort will be made to provide a secure facility for the meeting and to insure that attendees are properly identified, cleared, and in possession of the required need-to-know, all are reminded that the responsibility for the unauthorized disclosure, particularly with regard to conversations, rests with the individual attendee. Attendees are requested to keep in mind the following important points:

1. Be careful WHERE you make classified disclosures. Do not extend classified discussion to hotels, restaurants, officers' clubs, or other places in which you are unable to positively identify all within hearing distance and be reassured of the nonexistence of eavesdropping devices.

2. Be careful TO WHOM you make classified disclosures. You should assure yourself that the people to whom you are talking are indeed registrants at the 70th MORSS. You are advised that a uniformed or civilian person located away from the restricted area of the meeting and not personally recognized as a registrant does not have authorized access to classified information, regardless of his possession of a MORS name badge.

3. The attention of non-government attendees is invited to the National Industrial Security Program Operating Manual (NISPOM), Chapter 5, Section 5, with regard to disclosure authorizations.

4. Attendees are advised that possession of photographic, audio recording or electronic transmitting devices is not authorized in the meeting spaces of the 70th MORSS.

Admission Policy

Admission to the secure area of the meeting is limited to holders of current printed invitations properly authenticated and issued by the MORS office to the named individual for his attendance at the 70th MORSS.

Persons who enter or attempt to enter the secure area of the meeting without proper invitation and persons who aid, encourage, or willfully permit improperly authorized persons to enter the secure area of the meeting are liable for citation for security violation.

Invitations

The only admissible invitation is the official 70th MORSS Invitation issued by the MORS Office. Other invitations, including official invitations for earlier MORSS, are inadmissible. There is no provision for one-session-only invitations and MORS has no obligation to issue invitations after the announced deadline or to work out invitations for persons who arrive uninvited at the meeting. ***Invitations must be brought to the meeting. They are required for registration.***

Restricted Meeting Areas

Those portions of the meeting area lying inside of the posted guards are designated restricted meeting areas for the 70th MORSS. All classified presentations and discussions in connection with the MORSS program are to be conducted inside this area. Only the following persons are permitted access to MORS meeting areas:

- Officially invited 70th MORSS attendees with appropriate MORS-issued name badges and approved ID cards;
- MORS staff and service personnel with appropriate MORS-issued name badges and approved ID cards;
- Members of the 70th MORSS guard force;
- Officials representing the host command on official business.

Entry to the Meeting Areas

Entry to the restricted meeting areas will be regulated by the guard force and working group chairs and cochairs.

At each entry to the meeting area, each attendee will be required to stop long enough to show his properly validated 70th MORSS name badge and his identification and to be recognized by the guards. The name badge and ID card should be displayed at all times within the restricted meeting area. The guards or working group chairs and co-chairs will check the following before admitting an attendee to the classified area:

- The validity of the ID card
- The validity of the name badge
- The correspondence of face and ID picture
- The correspondence of name on badge and ID card.

So that the ID check can be accomplished quickly, name badges and ID cards must be displayed together in the MORS name badge holder.

Security Matters

Picture ID Cards

All attendees in the restricted meeting areas are required to display their ID cards in the MORS badge holders along with their name badges. Only two types of ID cards are permissible: the active duty military ID card **(military officers on active duty MUST be in uniform to use their military ID card)** and the ID card issued by MORS. The MORS-issued ID cards will be delivered to the attendees when they register. It is important that the attendee return the card to the MORS office when leaving the meeting. Otherwise, the attendee will have to obtain a new ID card for subsequent MORSS.

MORS Name Badges

A MORS name badge is issued to each properly registered attendee, along with a plastic pouch for its display. Attendees should take care that the badge is not lost or loaned during the meeting, as these are avenues for improper entry and security violations. Badges should not be changed, corrected, or altered in any way. If such action is necessary, a member of the MORS staff will issue and authenticate a new badge.

Note Taking

Classified presentations shall be delivered orally and/or visually. Classified documents shall not be distributed and classified note taking and electronic recordings shall not be permitted by attendees during classified presentations.

Classified Matter—Transmittal

For those who sent their classified matter ahead of time to the following address:

Director TRAC
Attn: MORSS (Natalie Kelly)
255 Sedgwick Avenue
Fort Leavenworth, KS 66027-2345

You may retrieve your package from the MORS Office, when you arrive at the Symposium, after 1000 on Tuesday, 18 June 2002. ***Please note:*** Capability to perform *major* reproduction of your materials once you arrive at MORSS WILL NOT be provided.

When no longer needed for the Symposium, attendees may bring their classified material to the MORS office to be wrapped for hand carry or transmittal to their parent activity. ***The attendee is responsible for providing a letter of transmittal to be included in the package.*** The meeting security staff will be responsible for proper wrapping and marking of inner and outer envelopes in accordance with Navy security regulations. The address for classified mail shown on the attendee's personal security voucher will be used for mailing purposes. MORS will accept responsibility for mailing a properly wrapped and sealed package by registered mail and will provide the attendee with a receipt for the sealed package. Because of congestion, MORS staff will not be able to wrap packages during the breaks between sessions.

Classified Material—Overnight Storage

The MORS office will accept (until 15 minutes after the end of the last session) and safeguard (for the meeting duration) classified material to the level of SECRET. Material will be accepted as a package rather than loose. Receipts must be presented on recovery of material by its holder. The MORS office staff is cleared to the SECRET level.

Classified Disclosure

Persons participating in the discussions at the 70th MORSS have been granted limited disclosure authorization via their personal security vouchers for the 70th MORSS. It is the individual responsibility of each participant to find out in advance, from his certifying official, the limits to his own classified disclosures and to stay within those limits at the symposium.

A written MORS Disclosure Form #712 A/B is required for all papers and presentations (government and contractor). All MORS Disclosure Forms #712 A/B must be forwarded to the MORS Security Manager before the presentation is given. If the disclosure form is not received by MORS prior to the symposium, the presentation will be canceled. Request additional disclosure forms from the MORS office or download them from www.mors.org.

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The purpose of the Military Operations Research Society is to enhance the quality and effectiveness of classified and unclassified military operations research. To accomplish this purpose, the Society provides media for professional exchange and peer criticism among students, theoreticians, practitioners, and users of military operations research. These media consist primarily of the traditional annual MORS symposia (classified), their published proceedings, special mini-symposia, workshops, colloquia and special purpose monographs. The forum provided by these media is directed to display the state of the art, to encourage consistent professional quality, to stimulate communication and interaction between practitioners and users, and to foster the interest and development of students of operations research. In performing its function, the Military Operations Research Society does not make or advocate official policy, nor does it attempt to influence the formulation of policy. Matters discussed or statements made during the course of its meetings or printed in its publications represent the positions of the individual participants and authors and not of the Society.

The Military Operations Research Society is operated by a Board of Directors consisting of 30 members, 28 of whom are elected by vote of the Board to serve a term of four years. The persons nominated for the Board generally are individuals who have attained recognition and prominence in the field of military operations research and who have demonstrated an active interest in the programs and activities of MORS. The remaining two members of the Board of Director's are the Past President who serves by right and the Executive Vice President who serves as a consequence of his position. A limited number of Advisory Directors are appointed from time to time, for a 1-year term, to perform some particular function. In addition to the members, the Society maintains a general distribution list of others to whom announcements, newsletters, and information are routinely sent.

The MORS Board of Directors wants to make the meetings and other operations of the Society as responsive as possible, both to the needs of the times and the desires of the members. Consequently, attendees are invited to communicate their relevant ideas and thoughts to any Officer or other Director or to the Society in writing. Where practicable, your communications will be duplicated and furnished to the MORS Board Members and Program Chairs for guidance in respect to future plans and operations.
The following are particularly encouraged:

- Offers of help in future symposium programs and working groups.
- Proposals for establishing new working groups.
- Suggestions for future keynote speakers, meeting themes, meeting sites, improvements in logistics.
- Criticism of current operations or programs.

The Society will consider all comments, suggestions and proposals.

MORS 2002 RIST PRIZE

CALL FOR PAPERS

MORS offers two prizes for best papers - the **Barchi** Prize and the **Rist** Prize. The Rist Prize will be awarded to the best paper in military operations research submitted in response to this Call for Papers. The Barchi Prize will be awarded to the best paper from the entire 70th MORS Symposium, including Working Groups, Composite Groups, and Special Sessions.

David Rist Prize: Papers submitted in response to this call will be eligible for consideration for the **Rist Prize.** The committee will select the prize-winning paper from those submitted and award the prize at the 71st MORSS. If selected, the author(s) will be invited to present the paper at the 71st MORSS and to prepare it for publication in the MORS journal, *Military Operations Research.* The cash prize is $1000. To be considered, the paper:

- Must be mailed to the MORS office and postmarked no later than **27 September 2002**;
- Cannot be more than 10,000 words OR 40 pages (including graphics).

Please send the original, three copies and a soft copy.

Richard H. Barchi Prize: Author(s) of those papers selected as the best from their respective Working Group or Composite Group, and those of the Special Sessions at the 70th MORSS will be invited to submit their paper for consideration for the **Barchi Prize.** The committee will select the prize-winning paper from among those presented, nominated and submitted. The prize will be presented at the 71st MORSS. The cash prize is $1000. To be considered, the paper must be mailed to the MORS office and postmarked no later than **22 November 2002**, cannot be more than 10,000 words OR 40 pages (including graphics). Please send the original, three copies and a soft copy.

Prize Criteria

The criteria for selection for both prizes are valuable guidelines for presentation and/or submission of any MORS paper. To be eligible for either award, a paper must, at a minimum:

- Be original and a self-contained contribution to systems analysis or operations research;
- Demonstrate an application of analysis or methodology, either actual or prospective;
- Prove recognizable new insight into the problem or its solution; and
- Not previously been awarded either the Rist Prize or the Barchi Prize (the same paper may compete for, but cannot win, both prizes.)

Eligible papers are judged according to the following criteria:

Professional Quality

- Problem definition
- Citation of related work
- Description of approach
- Statement of assumptions
- Explanation of methodology
- Analysis of data and sources
- Sensitivity of analyses (where appropriate)
- Logical development of analysis and conclusions
- Summary of presentation and results

Contribution to Military Operations Research

- Importance of problem
- Contribution to insight or solution of the problem
- Power of generality of the result
- Originality and innovation

70th MORSS Composite Group & Working Group Chairs

Military Operations Research at the Next Frontier

WG/CG Coordinator:		**Jack Keane**	**240-228-8886**	**jack.keane@jhuapl.edu**
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		George Stone	**703-696-9490**	**george.stone@osd.pentagon.mil**
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WG 3	Arms Control and Proliferation	Tom McIlvain	703-824-3148	tmcilvain@acsdefense-dc.com
WG 4	Air and Missile Defense	Bob Strider	256-955-5981	striderb@smdc.army.mil
CG B Space/C4ISR – Chair:		**Ted Bennett**	**228-688-4148**	**bennettt@navo.navy.mil**
WG 5	Operational Contribution of Space Systems	Steve Friedman	937-476-2509	sfriedman@dytn.veridian.com
WG 6	C4ISR	Jon Grossman	310-393-0411 x7622	jon_grossman@rand.org
WG 7	OR and Intel Analysis	Mark Youngren	703-883-6446	youngren@mitre.org
WG 8	IO/IW	Dick Deckro	937-255-6565 x4325	richard.deckro@afit.edu
WG 9	EW and Countermeasures	Mike Gauble	856-722-3774	Michael.f.gauble@lmco.com
WG 10	Unmanned Systems	James R Johnson	850-882-7652	james.johnson4@eglin.af.mil
WG 11	Military Environmental Factors	Gary McWilliams	301-394-2053	gmcwilliams@arl.army.mil
CG C Joint Warfare – Chair:		**Robert C Holcomb**	**703-578-2816**	**rholcomb@ida.org**
WG 12	Land and Expeditionary Warfare	Steve Riese	913-684-9119	rieses@trac.army.mil
WG 13	Littoral Warfare and Regional Sea Control	Terry McKearney	619-692-0558	mckearney@nosc.mil
WG 14	Power Projection	Trena Lilly	240-228-7142	trena.lilly@jhuapl.edu
WG 15	Air Power and Combat ID	Debbie Hall	937-476-2533	debbie.hall@veridian.com
WG 16	Special Operations and OOTW	COL Tim Hope	703-806-5617	hope@caa.army.mil
WG 17	Joint Campaign Analysis	LTC Barry Bazemore	913-684-9187	bazemoreb@trac.army.mil
CG D Resources - Chair:		**Herb Shukiar**	**310-393-0411 x7175**	**herb@rand.org**
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WG 19	Logistics, Reliability and Maintainability	Jane Krolewski	410-278-4657	hock@amsaa.army.mil
WG 20	Manpower and Personnel	Major Mike Kwinn	914-938-5941	fm9536@exmail.usma.army.mil
CG E Readiness/Training - Chair:		**Lt Col Greg McIntyre**	**703-696-9490**	**greg.mcintyre@osd.pentagon.mil**
WG 21	Readiness	Dan Cuda	703-578-2770	dcuda@ida.org
WG 22	Analytic Support to Training	Lt Col Joe Smith	703-784-6022	smithjg@mccdc.usmc.mil
WG 23	Battlefld Perf, Casualty Sustmt & Med Pln	Jim Mantock	972-437-5001	jmantock@scenpro.com
CG F Acquisition - Chair:		**John Ferguson**	**703-312-2364**	**jferguson@logicon.com**
WG 24	Measures of Effectiveness	MAJ Barry Ezell	757-467-1695	bcezell@aol.com
WG 25	Test and Evaluation	Charles Walters	703-578-6122	charles.walters@osd.mil
WG 26	Analysis of Alternatives	Bruce Wyman	703-971-3103 x162	bwyman@northrupgruman.com
WG 27	Cost Analysis	William Kroshl	240-228-4870	william.kroshl@jhuapl.edu
WG 28	Decision Analysis	Gwen F Delano	540-653-5047	gdelano@jwac.osis.gov
CG G Advances in Military OR - Chair:		**Hugh Dempsey**	**757-788-5822**	**dempseyh@monroe.army.mil**
WG 29	Modeling, Simulation and Wargaming	Jeff Dubois	937-476-2566	jdubois@dytn.veridian.com
WG 30	Revolution in Military Affairs	Matt Caffrey	334-953-6161/2526	matthew.caffrey@maxwell.af.mil
WG 31	Computing Advances in Military OR	Robert L Albright	573-596-0131 x35232	albrightr@wood.army.mil
WG 32	Social Science Methods	John Warner	520-538-4704	john.warner@hua.army.mil
WG P1	Warfighting Experimentation	Lauran Winter	757-836-2858	winterl@je.jfcom.mil

70th MORSS ROOM SCHEDULE

Composite Group	Working Group	Plenary	CG/WG #1	Tutorial #1	CG/WG #2	SS #1	CG/WG #3	CG/WG #4	Tutorial #2	CG/WG #5	SS #2	CG/WG #6	CG/WG #7	Tutorial #3	CG/WG #8	SS #3
		Tues, 0830	Tues, 1030	Tues, 1215	Tues, 1330	Tues, 1530	Wed, 0830	Wed, 1030	Wed, 1215	Wed, 1330	Wed, 1530	Thur, 0830	Thur, 1030	Thur, 1215	Thur, 1330	Thur, 1530
CG A	WG 1		Bell 19A		CG A (DuPuy Auditorium)		Bell 19A	Bell 19A		Bell 19AB *		Bell 19A	Bell 19A		Bell 19A	
	WG 2		GIF 351B				GIF 351B	GIF 351B		GIF 351B		GIF 351B	GIF 351B		GIF 351B	
	WG 3		GIF 351A				GIF 351A	GIF 351A		Bell 19A *		GIF 351A	GIF 351A			
	WG 4		GIF 357A				GIF 357A	GIF 357A		GIF 357A		GIF 357A	GIF 357A			
CG B	WG 5		Bell 20A		CG B (Marshall Auditorium)		Bell 20A	Bell 20A		Bell 20A		Bell 20A	Bell 20A		Bell 24B*	
	WG 6		Bell 20B				Bell 20B	Bell 20B		Bell 20B		Bell 20B	Bell 20B		Bell 20B	
	WG 6A						Bell 21B	GIF 357B								
	WG 7		GIF 351C				GIF 351C	GIF 351C		GIF 351C		GIF 351C	GIF 351C		GIF 351C	
	WG 8		Bell 21A				Bell 21A	Bell 21A		Bell 21A		Bell 21A	Bell 21A		Bell 21A	
	WG 9		GIF 351D				GIF 351D	GIF 351D		GIF 351D		GIF 351D	GIF 351D			
	WG 10		GIF 352A				GIF 352A	GIF 352A		GIF 352A		GIF 352A				
	WG 11		Bell CR6				Bell CR6	Bell CR6		Bell CR2 *		Bell CR6	Bell CR6		Bell CR6	
CG C	WG 12		GIF 352B		GIF 352B		CG C (Marshall Auditorium)	GIF 352B		GIF 352B		GIF 352B	GIF 352B		GIF 352B	
	WG 13		GIF 352C		GIF 352C			GIF 352C		GIF 352C		GIF 352C	GIF 352C		GIF 352C	
	WG 14		GIF 178		GIF 178			GIF 178		GIF 357C		GIF 178	GIF 178		GIF 178	
	WG 15	Plenary Session *Eisenhower Auditorium*	GIF 352D	Tutorial #1 *(See below for details)*	GIF 352D	Special Session #1 *(See below for details)*		GIF 352D	Tutorial #2 *(See below for details)*	GIF 352D	Special Session #2 *(See below for details)*	GIF 352D	GIF 352D	Tutorial #3 *(See below for details)*		Special Session #3 *(See below for details)*
	WG 16		GIF 357D		GIF 357D			GIF 357D		GIF 357D		GIF 357D	GIF 357D			
	WG 17		Bell 21B		Bell 21B			Bell 21B		Bell 21B		Bell 21B	Bell 21B		Bell 21B	
CG D	WG 18		Bell 19B		Bell 19B		Bell 19B	Bell 19B		CG D (Marshall Auditorium)		Bell 19B	Bell 19B		Bell 19B	
	WG 19		Bell 22A		Bell 22A		Bell 22A	Bell 22A				Bell 22A	Bell 22A		Bell 22A	
	WG 20		Bell 22B		Bell 22B		Bell 22B	Bell 22B				Bell 22B	Bell 22B		Bell 22B	
CG E	WG 21		GIF 357B		GIF 357B		GIF 357B	CG E (Marshall Auditorium)		GIF 357B		GIF 357B	GIF 357B		GIF 357B	
	WG 22		GIF 253A		GIF 253A		GIF 253A			GIF 253A		GIF 253A	GIF 253A		GIF 253A	
	WG 23		GIF 253B		GIF 253B		GIF 253B			GIF 253B		GIF 253B	GIF 253B			
CG F	WG 24		GIF 152		GIF 152		GIF 152	GIF 152		CG F (DuPuy Auditorium)		GIF 152	GIF 152		GIF 152	
	WG 25		GIF 357C		GIF 357C		GIF 357C	GIF 357C				GIF 357C	GIF 357C		GIF 357C	
	WG 26		GIF 254C		GIF 254C		GIF 254C	GIF 254C				GIF 254C	GIF 254C			
	WG 27		GIF 253C		GIF 253C		GIF 253C	GIF 253C				GIF 253C				
	WG 28		Bell 24A		Bell 24A		Bell 24A	Bell 24A				Bell 24A	Bell 24A		Bell 24A	
CG G	WG 29		Bell 24B		Bell 24B		Bell 24B	Bell 24B		Bell 24B *		Bell 24B	Bell 24B		Bell 24B*	
	WG 30		GIF 358A		GIF 358A		GIF 358A	GIF 358A		Bell 24B *		GIF 358A	GIF 358A		GIF 358A	
	WG 31		Bell CR2		Bell CR2		Bell CR2	Bell CR2		Bell CR2 *		Bell CR2	Bell CR2		Bell CR2	
	WG 31A							GIF 253B					GIF 253C			
	WG 32		GIF 358B		GIF 358B		GIF 358B	GIF 358B		GIF 358B		GIF 358B	GIF 358B		GIF 358B	
	P1		GIF 257AB		GIF 257AB		GIF 257AB	GIF 257AB		GIF 257AB		GIF 257AB	GIF 257AB		GIF 257AB	

Note: * = Joint Session

70th MORSS ROOM SCHEDULE

Composite Group	Working Group	Plenary Tues, 0830	CG/WG #1 Tues, 1030	Tutorial #1 Tues, 1215	CG/WG #2 Tues, 1330	SS #1 Tues, 1530	CG/WG #3 Wed, 0830	CG/WG #4 Wed, 1030	Tutorial #2 Wed, 1215	CG/WG #5 Wed, 1330	SS #2 Wed, 1530	CG/WG #6 Thur, 0830	CG/WG #7 Thur, 1030	Tutorial #3 Thur, 1215	CG/WG #8 Thur, 1330	SS #3 Thur, 1530
Demon-strations	JWARS		GIF 358C							GIF 358C						
	JMASS		GIF 358D							GIF 358D						
	STORM		GIF 254D							GIF 254D						
	NBCCrest		GIF 254A							GIF 254A						
MORS Office			Bell CR4A							Bell CR4A						
Exec.Council / 71st Program			GIF 253D							GIF 253D						
CG / WG Wrap Up																Bell CR6
Poster Session			GIF Lobby							GIF Lobby						
Sponsor Job Fair			Trophy Lounge							Trophy Lounge						
Tutorials	Step #1 of The Scientific Method: How To Define A Problem			DuPuy												
	Spreadsheet Analysis			Marshall					Marshall							
	Top Ten Secrets for Successful Application of Optimization								DuPuy							
	Complex Adaptive Systems and Agent Modeling for													Marshall		
Special Sessions	Barchi Prize Paper					DuPuy										
	Jr. / Sr. Analyst (Part 1)					Marshall										
	Homeland Security					Eisenhower										
	EBO / IO Workshop Briefs					Bell CR2										
	Jr. / Sr. Analyst (Part 2)										GIF 253ABCD					
	Counter-terrorism										Marshall					
	Space / Urban Warfare Workshop Briefs										DuPuy					
	Heritage															Bell CR2
	Transformation															Marshall

70th MORSS

Special Sessions and Tutorials Room Assignments

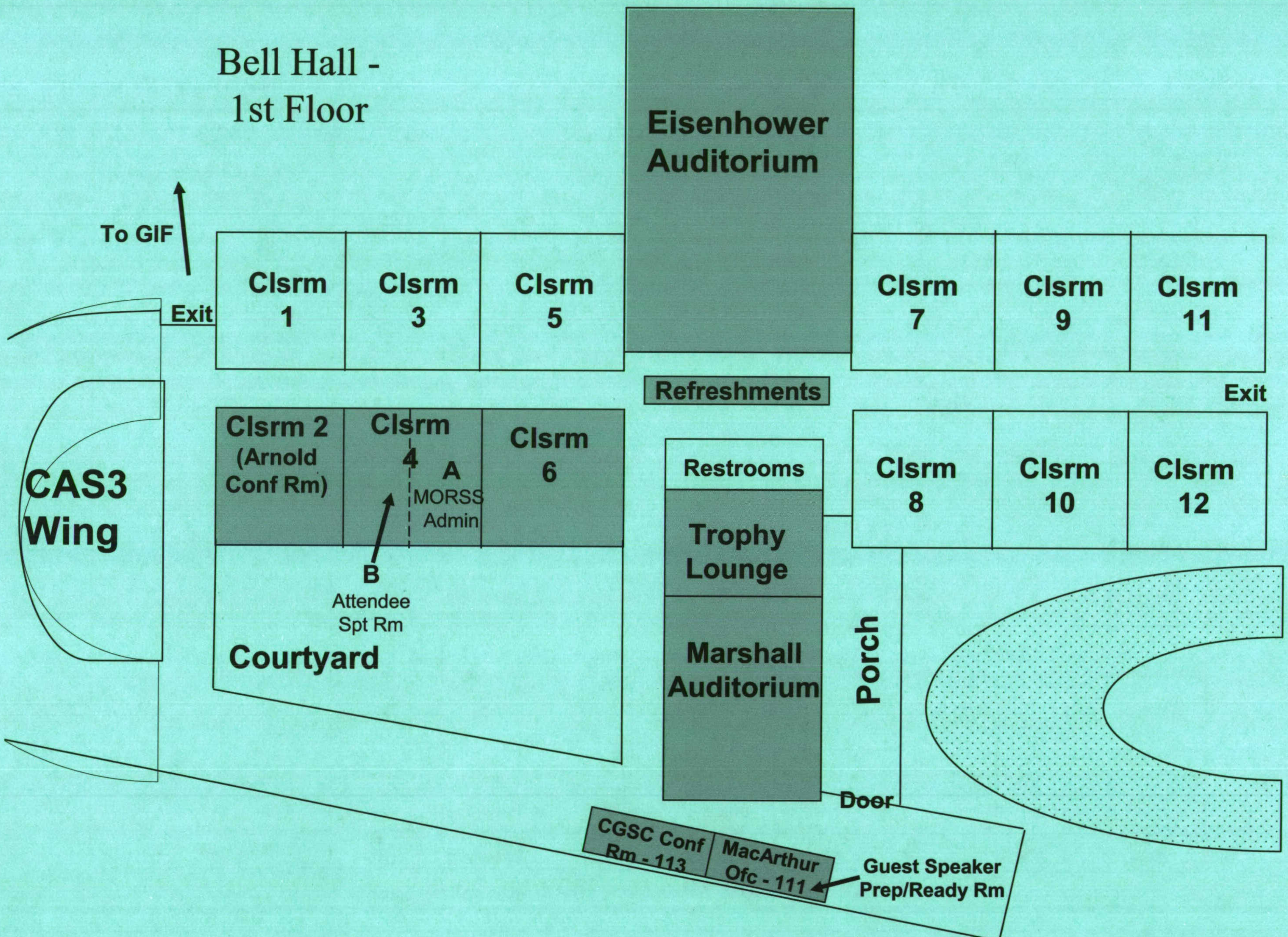
	Special Sessions and Tutorials	2002 70th MORSS Room
	Special Session #1 - Tuesday, June 18th, 1530-1700	
SS 1	Barchi Prize Award / Presentation	DuPuy
	Junior/Senior Analyst Session #1	Marshall
	Homeland Security	Eisenhower
	Workshop Briefs - Effects Based Operations/ Information Operations	Bell CR2
	Special Session #2 - Wednesday, June 19th, 1530-1700	
SS 2	Junior/Senior Analyst Session #2 (Army)	GIF 253A
	Junior/Senior Analyst Session #2 (Air Force)	GIF 253B
	Junior/Senior Analyst Session #2 (Naval)	GIF 253C
	Junior/Senior Analyst Session #2 (OSD / JS)	GIF 253D
	Counterterrorism	Marshall
	Workshop Briefs - Space/ Urban Warfare	DuPuy
	Special Session #3 - Thursday, June 20th, 1530-1700	
SS 3	Heritage Session - Mike Garrambone	Bell CR2
	Transformation	Marshall
	Tutorials - Tuesday, June 18th, 1215-1315	
	Spreadsheet Analysis	Marshall
	Step #1 Of The Scientific Method: How To Define A Problem	DuPuy
	Tutorials - Wednesday, June 19th, 1215-1315	
	Spreadsheet Analysis	Marshall
	Top Ten Secrets for Successful Application of Optimization	DuPuy
	Tutorials - Thursday, June 20th, 1215-1315	
	Complex Adaptive Systems and Agent Modeling for Military Analysis	Marshall

WG/CG SCHEDULE BY WORKING GROUP

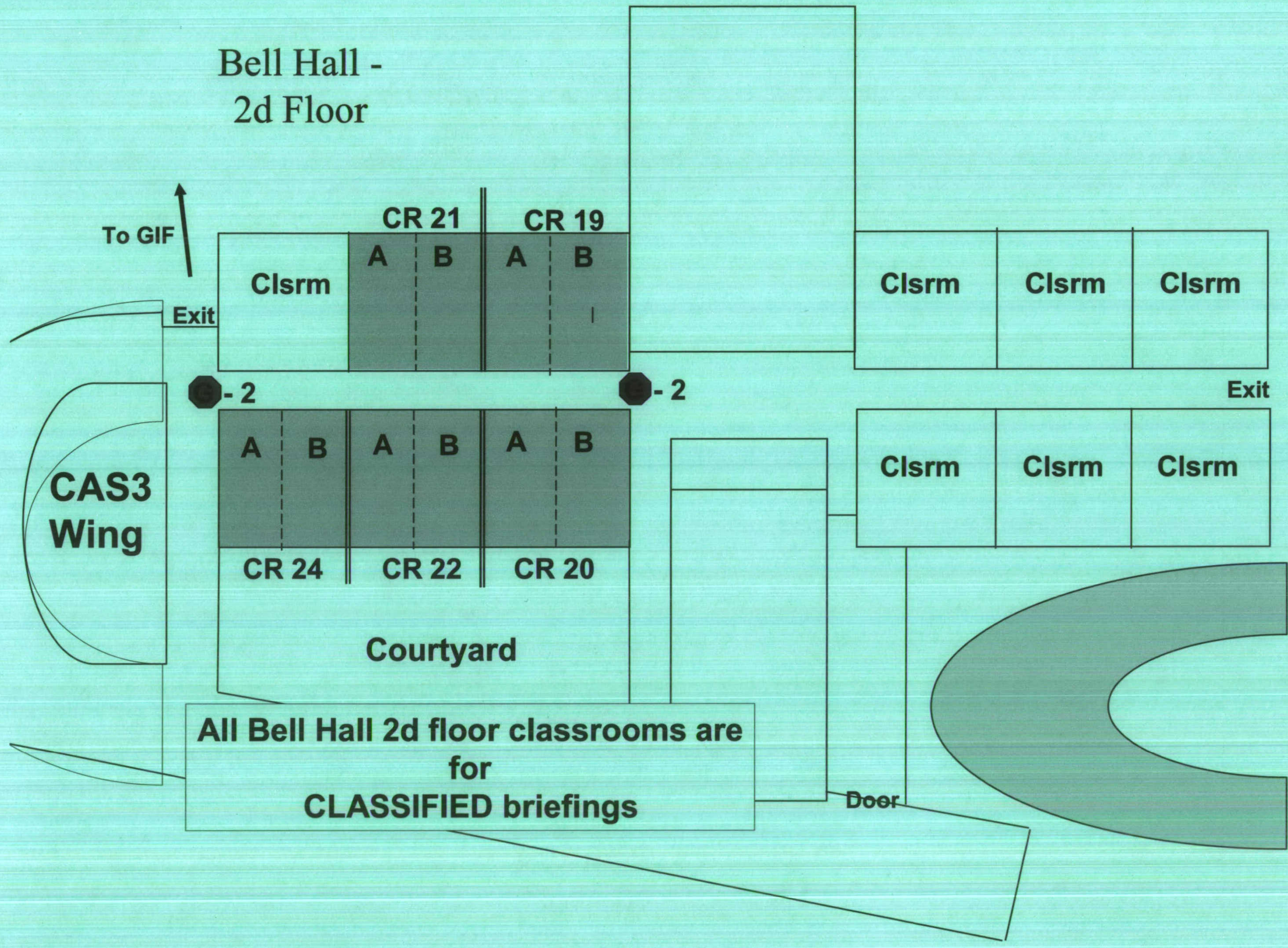
Composite Group	Working Group	Session 1 Tues, 1030	Session 2 Tues, 1330	Session 3 Wed, 0830	Session 4 Wed, 1030	Session 5 Wed, 1330	Session 6 Thur, 0830	Session 7 Thur, 1030	Session 8 Thur, 1330
CG A	WG 1	Bell 19A	CG A (DuPuy Auditorium)	Bell 19A	Bell 19A	**Bell 19A** *	Bell 19A	Bell 19A	Bell 19A
	WG 2	GIF 351B		GIF 351B	GIF 351B	GIF 351B	GIF 351B	GIF 351B	GIF 351B
	WG 3	GIF 351A		GIF 351A	GIF 351A	**Bell 19A** *	GIF 351A	GIF 351A	
	WG 4	GIF 357A		GIF 357A	GIF 357A	GIF 357A	GIF 357A	GIF 357A	
CG B	WG 5	Bell 20A	CG B (Marshall Auditorium)	Bell 20A	Bell 20A	Bell 20A	Bell 20A	Bell 20A	**Bell 24B** *
	WG 6	Bell 20B		Bell 20B	Bell 20B	Bell 20B	Bell 20B	Bell 20B	Bell 20B
	WG 6A			Bell 21B	GIF 357B				
	WG 7	GIF 351C		GIF 351C	GIF 351C	GIF 351C	GIF 351C	GIF 351C	GIF 351C
	WG 8	Bell 21A		Bell 21A	Bell 21A	Bell 21A	Bell 21A	Bell 21A	Bell 21A
	WG 9	GIF 351D		GIF 351D	GIF 351D	GIF 351D	GIF 351D	GIF 351D	
	WG 10	GIF 352A		GIF 352A	GIF 352A	GIF 352A	GIF 352A		
	WG 11	Bell CR6		Bell CR6	Bell CR6	**Bell CR2** *	Bell CR6	Bell CR6	Bell CR6
CG C	WG 12	GIF 352B	GIF 352B	CG C (Marshall Auditorium)	GIF 352B	GIF 352B	GIF 352B	GIF 352B	GIF 352B
	WG 13	GIF 352C	GIF 352C		GIF 352C	GIF 352C	GIF 352C	GIF 352C	GIF 352C
	WG 14	GIF 178	GIF 178		GIF 178	GIF 357C	GIF 178	GIF 178	GIF 178
	WG 15	GIF 352D	GIF 352D		GIF 352D	GIF 352D	GIF 352D	GIF 352D	
	WG 16	GIF 357D	GIF 357D		GIF 357D	GIF 357D	GIF 357D	GIF 357D	
	WG 17	Bell 21B	Bell 21B		Bell 21B	Bell 21B	Bell 21B	Bell 21B	Bell 21B
CG D	WG 18	Bell 19B	Bell 19B	Bell 19B	Bell 19B	CG D (Marshall Auditorium)	Bell 19B	Bell 19B	Bell 19B
	WG 19	Bell 22A	Bell 22A	Bell 22A	Bell 22A		Bell 22A	Bell 22A	Bell 22A
	WG 20	Bell 22B	Bell 22B	Bell 22B	Bell 22B		Bell 22B	Bell 22B	Bell 22B
CG E	WG 21	GIF 357B	GIF 357B	GIF 357B	CG E (Marshall Auditorium)	GIF 357B	GIF 357B	GIF 357B	GIF 357B
	WG 22	GIF 253A	GIF 253A	GIF 253A		GIF 253A	GIF 253A	GIF 253A	GIF 253A
	WG 23	GIF 253B	GIF 253B	GIF 253B		GIF 253B	GIF 253B	GIF 253B	
CG F	WG 24	GIF 152	GIF 152	GIF 152	GIF 152	CG F (DuPuy Auditorium)	GIF 152	GIF 152	GIF 152
	WG 25	GIF 357C	GIF 357C	GIF 357C	GIF 357C		GIF 357C	GIF 357C	GIF 357C
	WG 26	GIF 254C	GIF 254C	GIF 254C	GIF 254C		GIF 254C	GIF 254C	
	WG 27	GIF 253C	GIF 253C	GIF 253C	GIF 253C		GIF 253C		
	WG 28	Bell 24A	Bell 24A	Bell 24A	Bell 24A		Bell 24A	Bell 24A	Bell 24A
CG G	WG 29	Bell 24B	Bell 24B	Bell 24B	Bell 24B	**Bell 24B** *	Bell 24B	Bell 24B	**Bell 24B** *
	WG 30	GIF 358A	GIF 358A	GIF 358A	GIF 358A	**Bell 24B** *	GIF 358A	GIF 358A	GIF 358A
	WG 31	Bell CR2	Bell CR2	Bell CR2	Bell CR2	**Bell CR2** *	Bell CR2	Bell CR2	Bell CR2
	WG 31A				GIF 253B			GIF 253C	
	WG 32	GIF 358B	GIF 358B	GIF 358B	GIF 358B	GIF 358B	GIF 358B	GIF 358B	GIF 358B
	P1	GIF 257AB	GIF 257AB	GIF 257AB	GIF 257AB	GIF 257AB	GIF 257AB	GIF 257AB	GIF 257AB
Demonstrations	JWARS	GIF 358C							
	JMASS	GIF 358D							
	STORM	GIF 254D							
	NBCCrest	GIF 254A							
MORS Office		**Bell CR4A**							
Exec. Committee / 71st Program Staff		GIF 253D							

Note: * = Joint Session

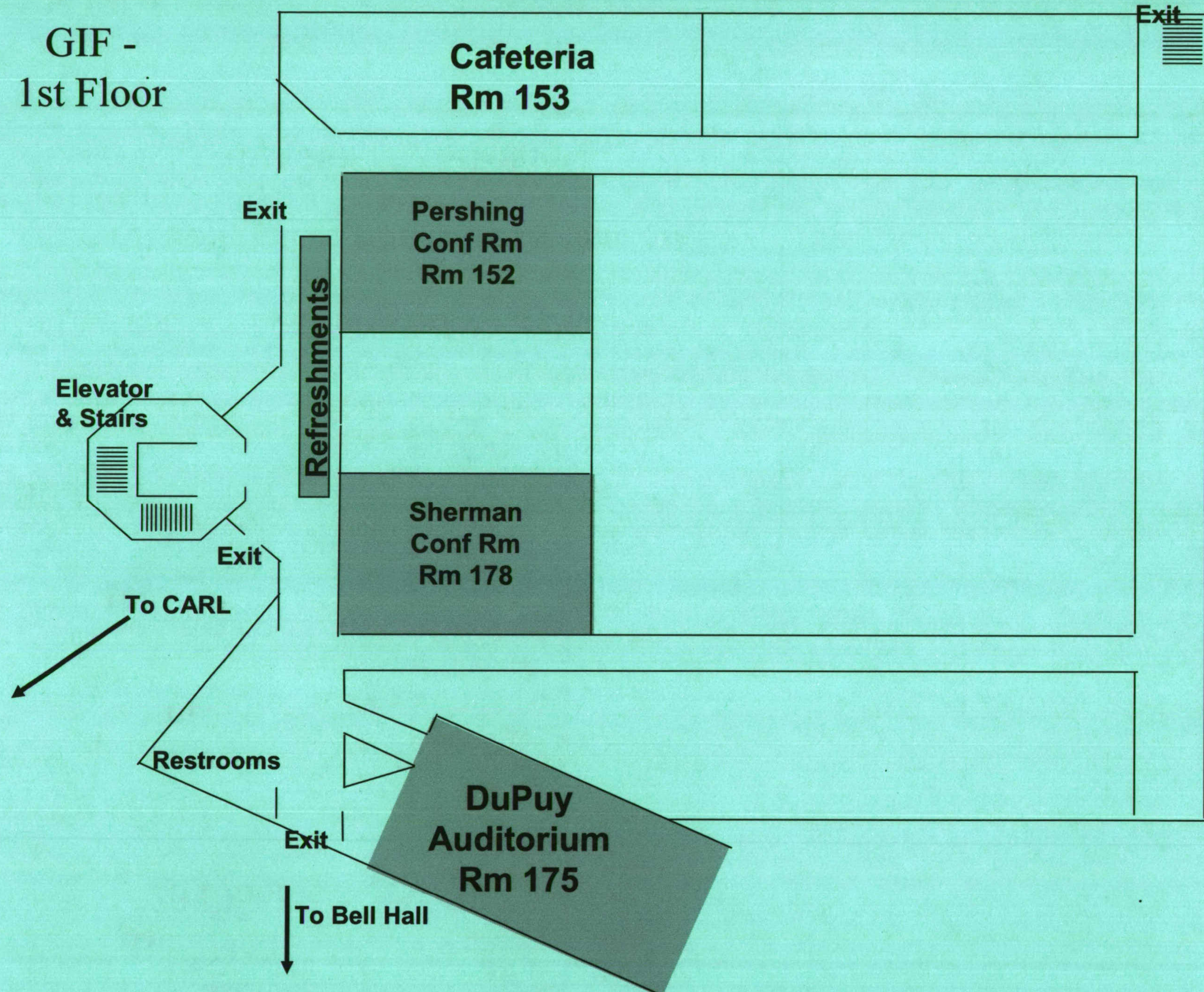
Bell Hall - 1st Floor



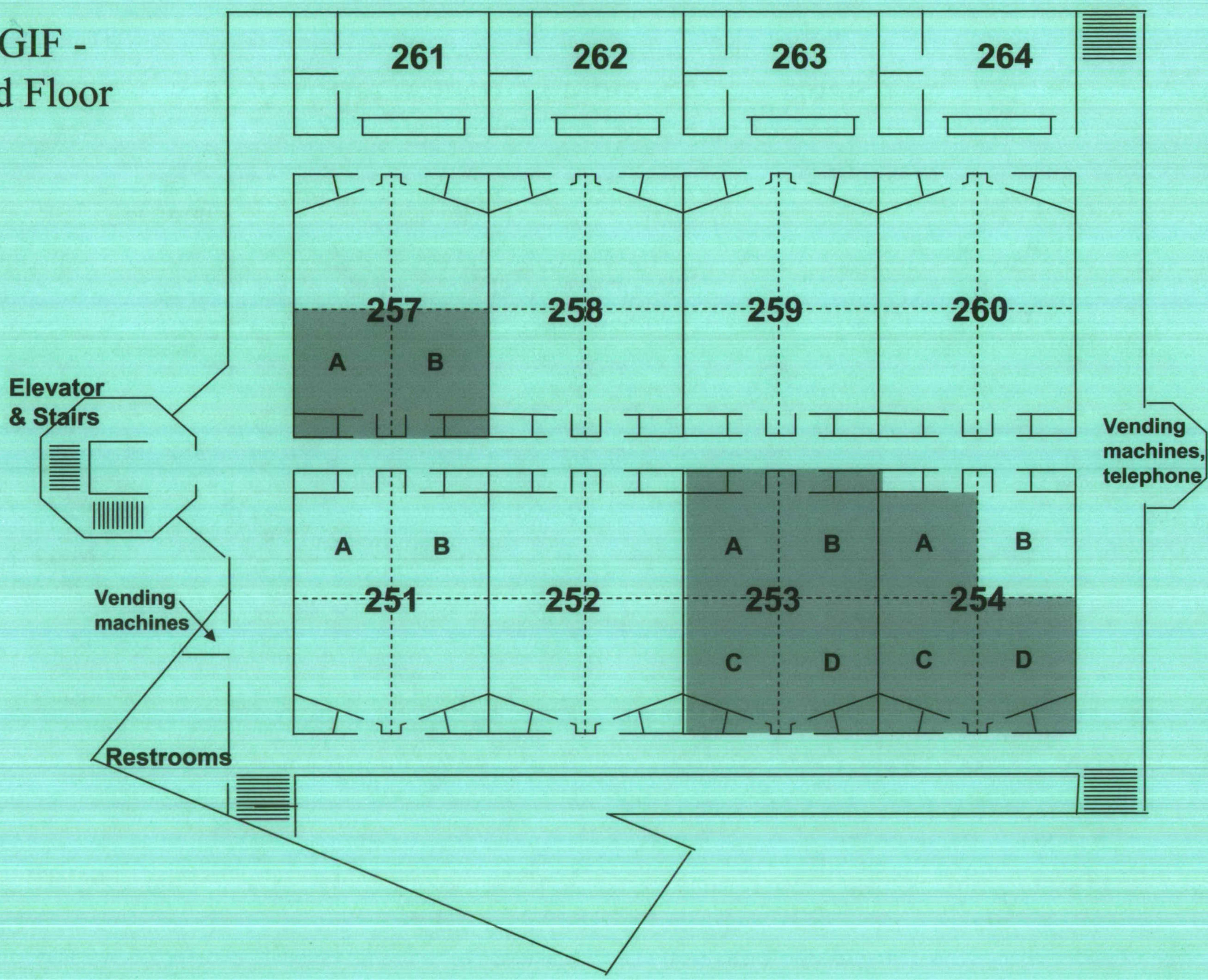
Bell Hall - 2d Floor



GIF - 1st Floor



GIF - 2d Floor


261
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Elevator
& Stairs
Vending
machines,
telephone
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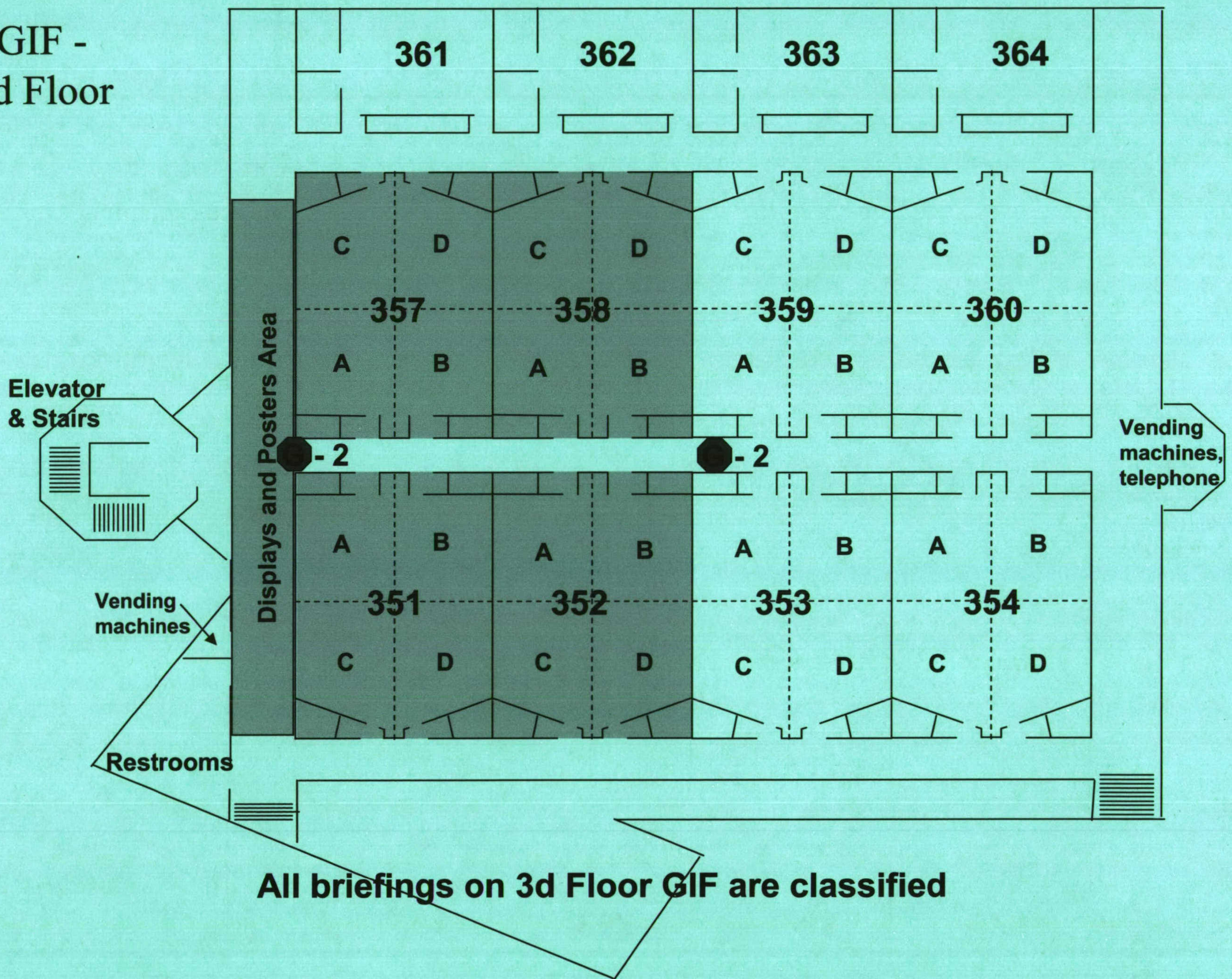
D
Vending
machines
Restrooms

GIF - 3d Floor



All briefings on 3d Floor GIF are classified

70th MORSS Bus Schedule

Buses are provided by Easton Bus Service, Inc. and will be marked for MORS

TUESDAY, 18 JUNE

DEPARTURES	***FROM*** HOTELS[1]	***TO*** BELL HALL	**6:00 & 7:30 AM**
(Registration is at Bell Hall 7:00-8:30 AM; Plenary starts at 8:30)			
SHUTTLES *between* Bell Hall *and* Frontier Conference Center for Solarium buffet			**11:45 AM-1:30 PM**
BUSES	***FROM*** BELL HALL	***TO*** HOTELS[1]	**5:15-7:15 PM**
(Transportation available before, during and after Frontier Army Museum Mixer)			

WEDNESDAY, 19 JUNE

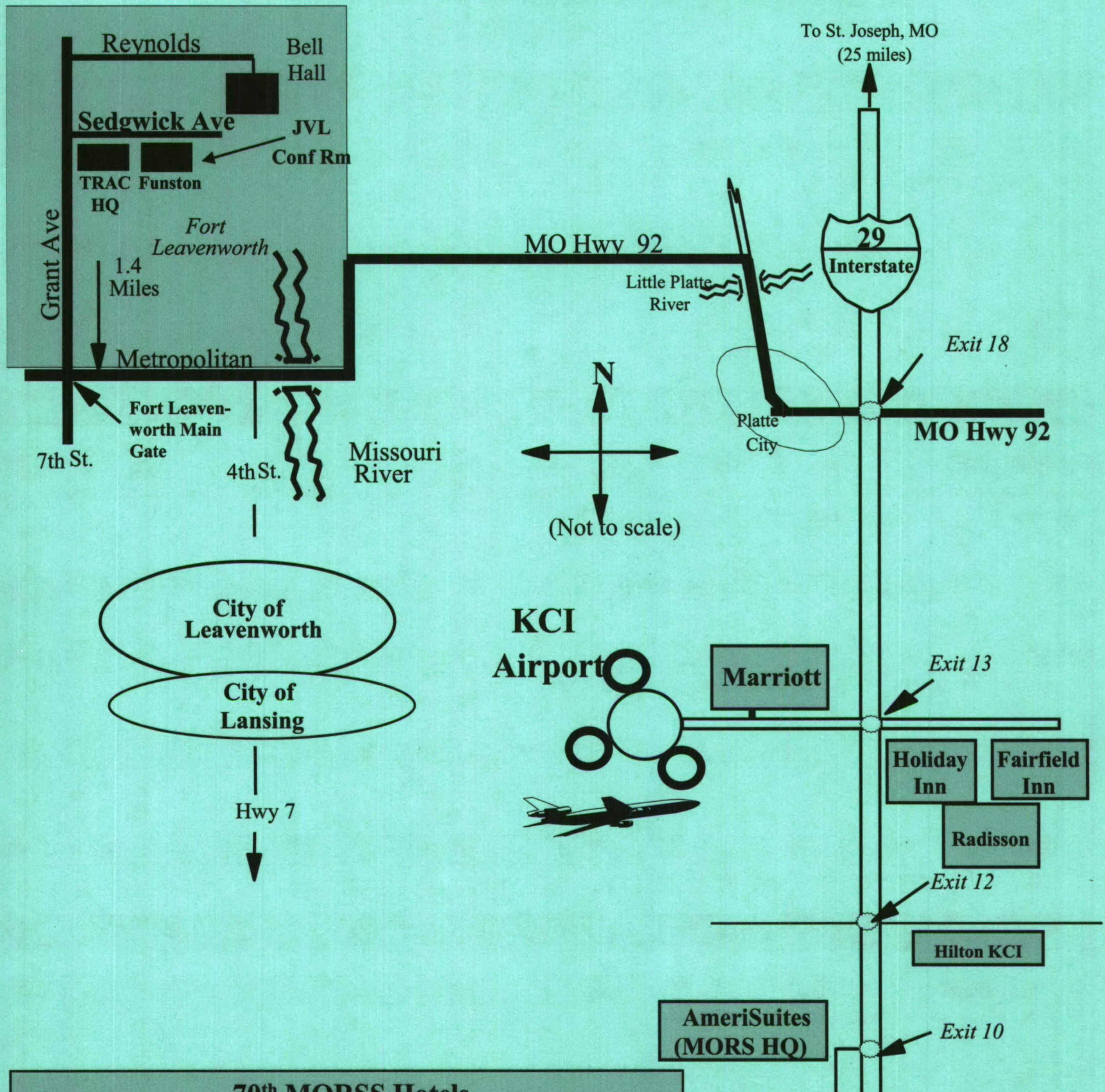
DEPARTURES	***FROM*** HOTELS[1]	***TO*** BELL HALL	**6:00 & 7:30 AM**
(Early Buses drop invitees for Town Hall and Editors' breakfasts that start at 7:00 at FCC, then go on to Bell Hall; Buses will pick up breakfast attendees at FCC at about 8:00; First WG/CG sessions start at 8:30)			
SHUTTLES *between* Bell Hall *and* Frontier Conference Center for Solarium buffet			**11:45 AM-1:30 PM**
BUSES	***FROM*** BELL HALL	***TO*** HOTELS[1]	**5:15 PM**
(Departure in time for bus service to Steamboat Arabia Museum Dinner)			
BUSES	***FROM*** HOTELS[1]	***TO*** Steamboat Arabia Museum	**6:00 PM**
(Dinner begins at 6:30)			
BUSES	***FROM*** Steamboat Arabia Museum	***TO*** HOTELS[1]	**8:30-10:00 PM**
(Transportation available until all are returned from Dinner)			

THURSDAY, 20 JUNE

DEPARTURES	***FROM*** HOTELS[1]	***TO*** BELL HALL	**6:00 & 7:30 AM**
(First WG sessions start at 8:30)			
SHUTTLES *between* Bell Hall *and* Frontier Conference Center for Solarium buffet			**11:45 AM-1:30 PM**
Periodic BUSES	***FROM*** BELL HALL	***TO*** HOTELS & KCI Airport	**12:15 – 5:15 PM**
(Buses will leave Fort Leavenworth periodically throughout the afternoon to make a circuit of Hotels[1] & KCI Airport as needed by attendees)			

[1] Hotels with Bus service are: 1) Amerisuites and Mainstay Suites (I29/Exit 10); 2) Hilton KCI (I29/Exit 12); 3) Radisson Hotel, Holiday Inn KCI and Fairfield Inn KCI (Plaza Circle—East of I29/Exit 13); 4) Kansas City Airport Marriott (West of I29/Exit 13).

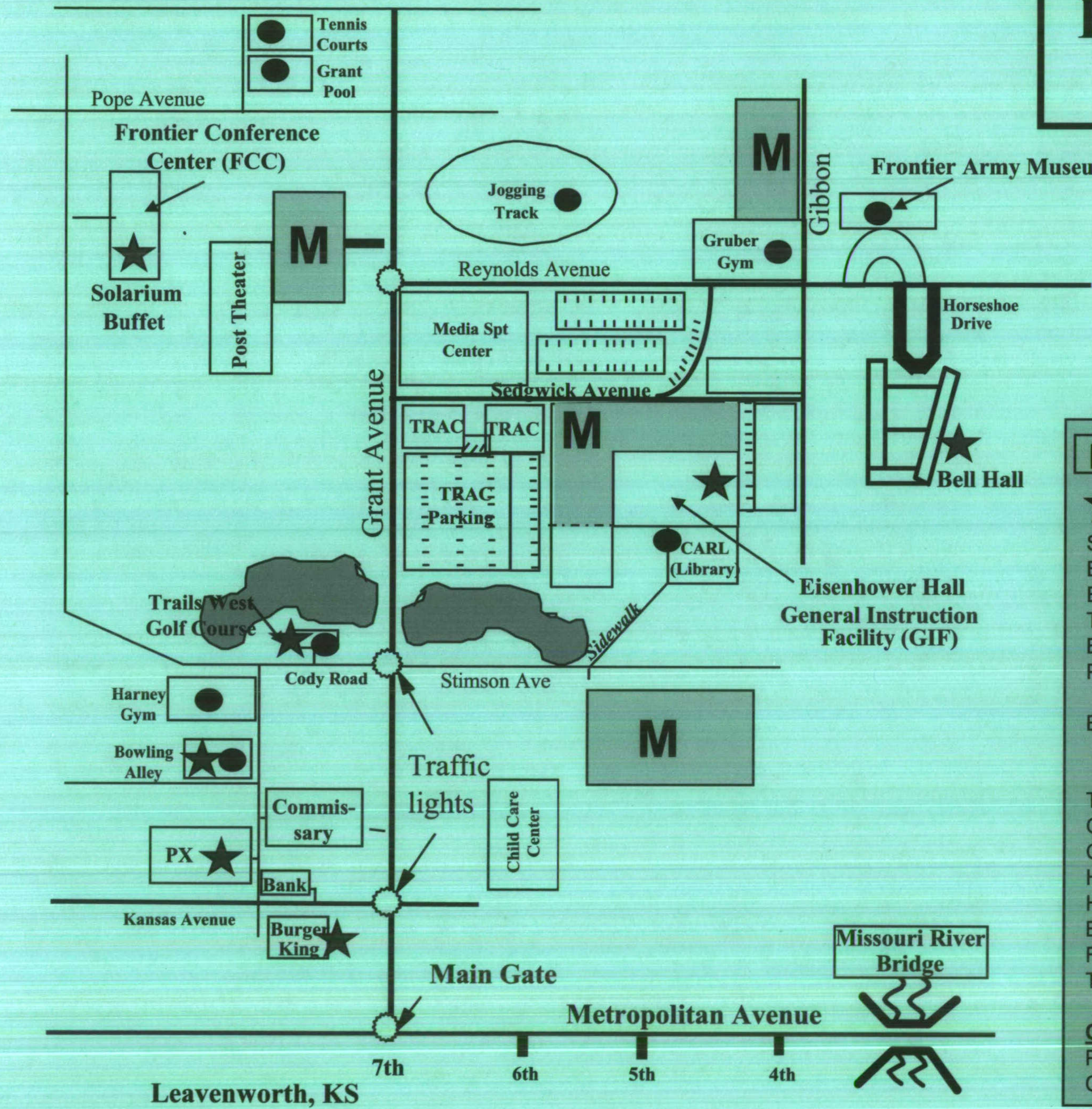
Route from KC Airport and 70th MORSS Hotels to Fort Leavenworth



70th MORSS Hotels

AmeriSuites (MORS HQ)	7600 NW 97th Terrace	816-891-0871
MainStay Suites	9701 N. Shannon Ave	816-891-8500
Hilton KCI	8801 NW 112th St	816-891-8900
Radisson	11828 NW Plaza Circle	816-464-2423
Holiday Inn KCI	11832 Plaza Circle	816-464-2345
Fairfield Inn KCI	11820 NW Plaza Circle	816-464-2424
KC Airport Marriott	775 Brasilia Ave	816-464-2200

Ft Leavenworth Facilities



Not to scale

N

M **MORS Parking**

★ **Lunch Facility**

Solarium Buffet (Frontier Conf Center)
Bell Hall Cafeteria (same food as PX Mall)
Eisenhower Hall Cafeteria (GIF)
Trails West Gof Course Snack Bar
Burger King
PX Mall (Taco Bell, Robin Hood,
Deli, Anthony's Pizza)
Bowling Center Snack Bar

● **Recreational Facility**

Trails West Golf Course (0730-dusk)
Grant Pool (outdoors) (1000-2000)
Gruber Gym (0630-2200)
Harney Gym ((0630-2200)
Harney Gym Indoor Swimming Pool
Bowling Alley (1100-2000)
Frontier Army Museum/Gift Shop (0800-1600)
Tennis Courts (Daylight-2000)

Other Facilities

PX (0900-2100)
Commissary (1000-1800)

Lunch on Ft. Leavenworth

Solarium Buffet (Frontier Conference Center)	multi-course lunch buffet
Bell Hall Cafeteria	cafeteria-style, deli sandwiches, pizza, etc.
Trails End Golf Course Snack Bar	variety, grilled orders
Burger King	
PX Mall (Taco Bell, Robin Hood Deli, Anthony's Pizza)	
Bowling Center Snack Bar	variety, grilled orders

==

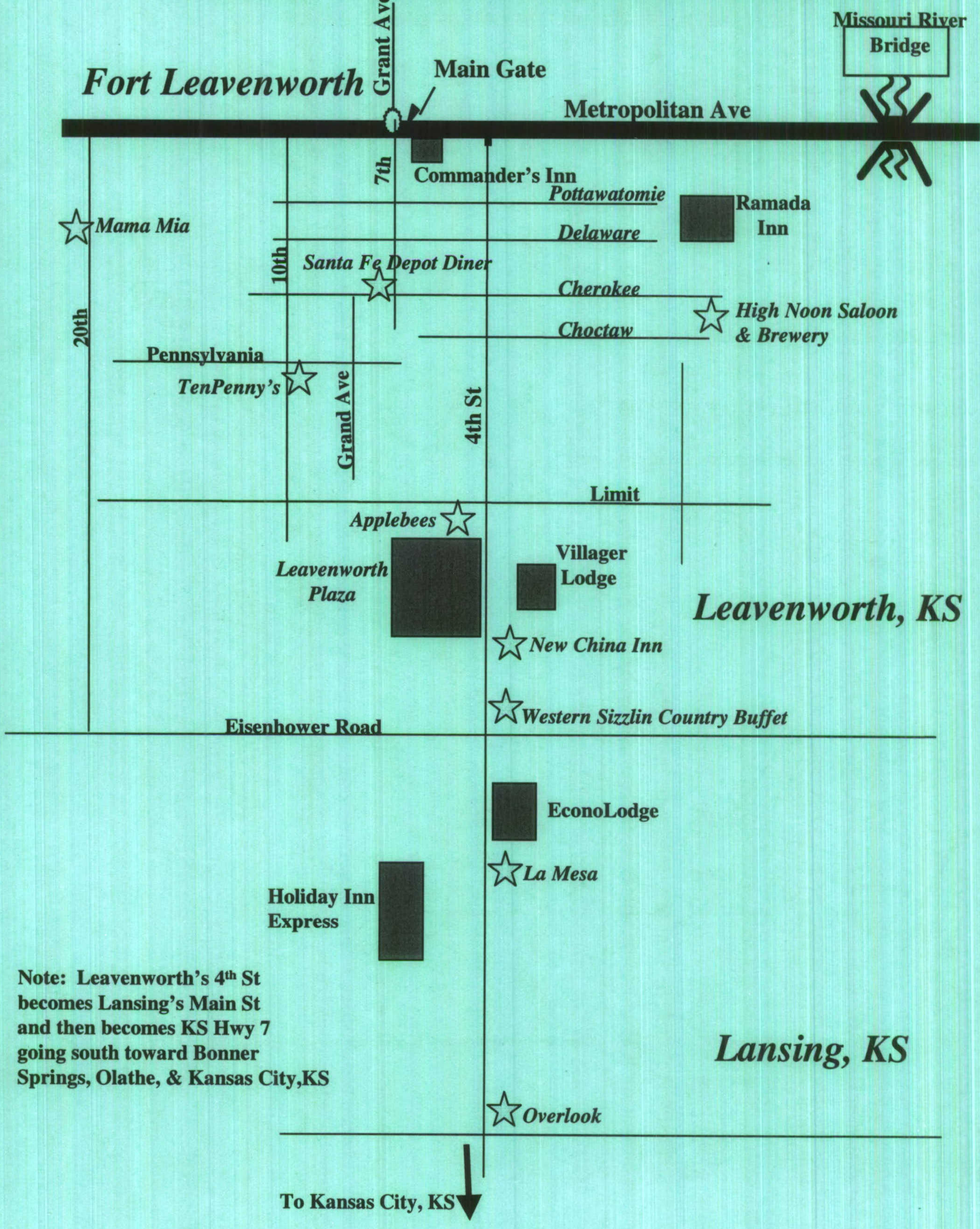
Restaurants in Leavenworth Area

Many of the nationally franchised "fast-food" eateries are available in Leavenworth – nearly all are located on the 4th Street/KS Highway 7 corridor. Additional restaurants in the area are listed below (note: this partial listing does not imply endorsement).

*America Bowman Restaurant	500 Welt	Weston, MO	816-640-5235
Applebee's	2912 S. 4th St	Leavenworth	758-1010
*Avalon Cafe	608 Main	Weston, MO	816-640-2835
*Fannie's *(Home Style Buffet)*	600 Prairie View Rd	Platte City, MO	816-431-5675
High Noon Saloon & Brewery	206 Choctaw	Leavenworth	682-4976
Hunan Chopsticks *(Chinese Buffet)*	608 Pottawatomie	Leavenworth	651-6728
King Buffet *(Chinese/Korean)*	201 N. 5th	Leavenworth	682-7661
Korea House	749 Shawnee	Leavenworth	682-0705
Mama Mia's Italian Ristorante	402 S. 20th	Leavenworth	682-2131
New China Inn	3519 S. 4th	Leavenworth	651-8088
Oasis Café *(Mediterranean)*	604 Cherokee	Leavenworth	772-0888
*O'Malley's 1842 Irish Pub	500 Welt	Weston, MO	816-640-5235
Overlook Restaurant	720 1st Terrace	Lansing	727-3313
*Paolucci's Restaurant & Lounge	113 S 3d	Atchison	367-6105
*River House Restaurant	101 Commercial	Atchison	367-1010
Santa Fe Depot Diner	781 Shawnee	Leavenworth	651-6156
*Skyview Restaurant	504 Grand Ave	Leavenworth	682-2653
Tenpenny's	1701 10th Ave	Leavenworth	651-1010
The Tea Room	505 Delaware	Leavenworth	682-0777
Towne Pub	1001 Ottawa	Leavenworth	682-5456
Up Above	800 N Main	Lansing	727-3223
*Vineyard Restaurant	505 Spring	Weston	816-640-5588
Western Sizzlin' Buffet	5041 S 4th	Leavenworth	727-3054

(* due to distances, recommended for evening dining; reservations recommended)

Fort Leavenworth Area
Representative Dining & Lodging



Note: Leavenworth's 4th St becomes Lansing's Main St and then becomes KS Hwy 7 going south toward Bonner Springs, Olathe, & Kansas City,KS

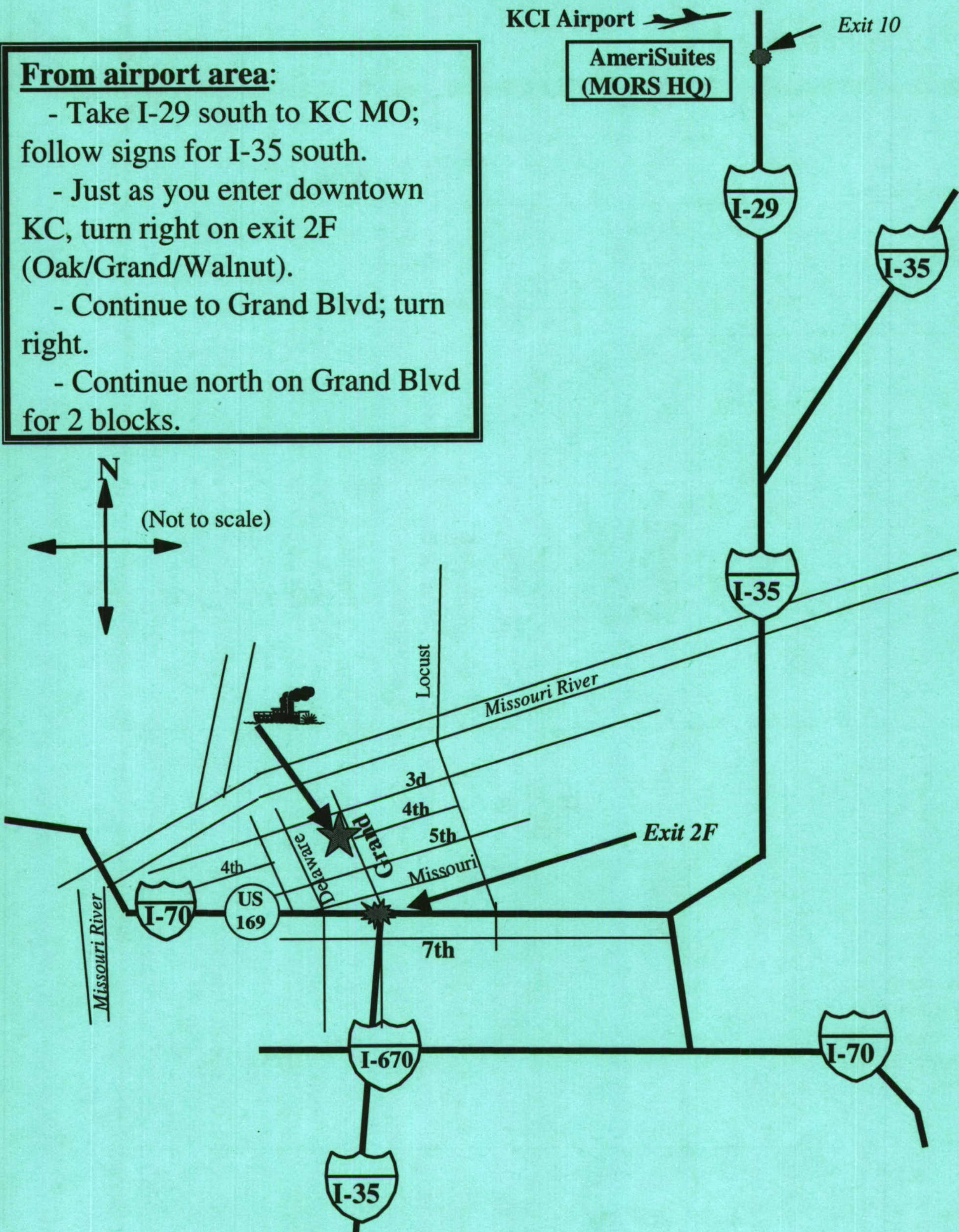
Steamboat Arabia Museum -

Kansas City, MO in the City Market area

400 Grand Blvd (between 5th & 3d streets)

<u>From airport area</u>:

- Take I-29 south to KC MO; follow signs for I-35 south.
- Just as you enter downtown KC, turn right on exit 2F (Oak/Grand/Walnut).
- Continue to Grand Blvd; turn right.
- Continue north on Grand Blvd for 2 blocks.



1. Evaluation of 70th MORSS

The MORS Board of Directors and Symposium Staff want to improve MORS Symposia to better respond to your needs and to improve the quality of military operations research. Your evaluation is very important and your comments will be considered in planning future events. Please complete this questionnaire and return it to your Composite Group or Working Group Chair; the MORS Office in **Bell Hall Room 4A** or mail it to MORS, 1703 N. Beauregard Street, #450, Alexandria VA 22311-1717. Thank you.

Background Information:

- **Name** (optional) ______________________________

- **What is your affiliation?**

Military:	❑ USA	❑ USN	❑ USAF	❑ USMC	❑ USCG
Civilian:	❑ USA	❑ USN	❑ USAF	❑ USMC	❑ USCG
	❑ Other DoD	❑ FFRDC	❑ Joint/Unified Staff/Command		❑ Other Federal Gov't
	❑ Academic	❑ Consultant	❑ Professional Services Firm		❑ Manufacturing Firm
	❑ Other ______________________________				

- **Including this MORSS, how many MORS Symposia have you attended?**__________

- **Please check membership in other professional organizations?**

❑ American Aeronautical Society (AAS)

❑ American Society of Naval Engineers (ASNE)

❑ Association of Old Crows (AOC)

❑ American Institute for Aeronautics and Astronautics (AIAA)

❑ Armed Forces Communications and Electronics Assoc (AFCEA)

❑ Electronic Industries Association (EIA)

❑ International Council on Systems Engineering (INCOSE)

❑ Institute for Operations Research and Management Science (INFORMS)

❑ International Test and Evaluation Association (ITEA)

❑ Military Applications Society (MAS)

❑ National Defense Industrial Association (NDIA)

❑ The Society of American Military Engineers (SAME)

❑ Washington Institute for Operations Research and Management Science (WINFORMS)

Others? (Please List)

____

____

- **Do you plan on attending the 71st MORSS at the MCB, Quantico, VA, 10 - 12 June 2003?**

❑ YES ❑ Probably ❑ 50/50 ❑ Probably NO ❑ NO

If no or probably no, why not? ______________________________

____

____

____

2. Evaluation of 70th MORSS

	Very Poor 1	Poor 2	Fair 3	Good 4	Excellent 5	Does Not Apply
a. **OVERALL**, how do you rate the 70th MORSS in meeting your needs?						
b. Please give your assessment of each **SPECIAL SESSION** (SS) you attend (print the session name in the blank) and then an overall assessment of the Special Sessions meeting your needs.						
(1) SS 1 ____________________						
(2) SS 2 ____________________						
(3) SS 3 ____________________						
(4) Special Sessions overall						
(5) View of Prize Awards/Papers as a Special Session?						
(6) How can SS be improved?						
c. Please give your assessment of each **TUTORIAL SESSION** and your overall assessment of Tutorials meeting your needs.						
(1) TUE ____________________						
(2) WED ____________________						
(3) THU ____________________						
(4) Tutorials overall						
(5) How can Tutorials be improved?						
d. Please give your assessment of each **COMPOSITE GROUP** and the overall assessment of the CG meeting your needs.						
(1) CG A - Strategic & Defense						
(2) CG B - Space/C4ISR						
(3) CG C - Joint Warfare						
(4) CG D - Resources						
(5) CG E - Readiness/Training						
(6) CG F - Acquisition						
(7) CG G - Advances in MOR						
(8) Composite Groups overall						
(9) How can CG's be improved?						
e. Please give your assessment of each **WORKING GROUP** Session and give your overall assessment of the WG meeting your needs.						
(1) 1st WG Session - WG# _____						
(2) 2nd WG Session - WG# _____						
(3) 3rd WG Session - WG# _____						
(4) 4th WG Session - WG# _____						
(5) 5th WG Session - WG# _____						
(6) 6th WG Session - WG# _____						
(7) 7th WG Session - WG# _____						
(8) 8th WG Session - WG# _____						
(9) Working Groups overall						
(10) How can WGs be improved?						
f. Please give your assessment of the following other events and provide suggestions for improvement.						
(1) Mixer						
(2) Poster Presentations						
(3) Guest Tour						
(4) Steamboat Arabia Museum Dinner						
(5) Demonstrations						
(6) Government Job Fair						

3. Evaluation of 70th MORSS

	Very Poor 1	Poor 2	Fair 3	Good 4	Excellent 5	Does Not Apply
How helpful to you are the MORS Symposia in the following areas?						
a. Receiving help on a current project						
b. Learning about new data sources						
c. Learning about models/techniques that you may use						
d. Meeting colleagues you can consult with in the future						
e. Becoming aware of new problems requiring analysis						
f. Broadening perspectives of military operations research						
g. Other ______________________						
h. Overall, how can MORS Symposia be improved to meet your needs?						

4. Evaluation of 70th MORS Activities

	Not Satisfied 1	2	Satisfied 3	4	Very Satisfied 5	No Opinion
a. How satisfied are you with the way MORS is being managed?						
b. How helpful are the following MORS publications/media for you or your organization?						
(1) Monographs						
(2) *Military Operations Research Journal*						
(3) *PHALANX*						
(4) *Military OR Analyst's Handbook*						
(5) MORS Web Page						
c. How helpful are the following MORS activities for you and your organization?						
(1) MORS Symposium						
(2) Mini-symposia						
(3) Workshops						
(4) Colloquia						

d. Suggestions for further activities:	Do Not Support		Support		Strongly Support	No Opinion
(1) Hold more joint meetings with other professional associations						
(2) Other (please specify)						
(3) Would you be willing to volunteer your time and effort to pursue any of these?	<u>Yes</u>	<u>No</u>	If so, which one(s)? (please list =>)			

5. Other Comments or Suggestions

Please feel free to continue writing on the back or attaching additional sheet(s).

6. Other Comments or Suggestions (cont.)

Please feel free to continue writing on the back or attaching additional sheet(s).

Place
1st Class
postage
here

Return to:

Military Operations Research Society
1703 N. Beauregard Street #450
Alexandria VA 22311-1717

Strategic Operations WG-1

Chair: Jon Davis, Naval Warfare Center
Co-chairs: Doug Anson, Los Alamos National Laboratory
1st Lt. Sharon Christ, USSTRATCOM/J534
Advisor: William Bearden, Los Alamos National Laboratory
Bell Hall 19A

The following abstracts are listed in alphabetical order by principal author.

High Rollers: Modeling Autocrats' Risk Acceptance in Unstable Regimes

Prof Stephen Biddle
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Strategic Studies Institute
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(717) 245-4128 (fax (717) 245-3820)
stephan.biddle@carlisle.army.mil

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A central feature of U.S. strategy in the War on Terrorism has been our reliance on deterring or coercing state sponsors of terrorism: by threatening force we seek to coerce otherwise unwilling states (Such as Yemen, Somalia, or Sudan) to crack down on terrorists within their borders without an actual U.S. attack. Success in such coercive campaigns depends heavily on the targets' risk acceptance. The more risk averse the leader, the more likely the state is to comply with our demands without actual U.S. intervention. The more risk acceptant, on the other hand, the more likely the state will be to test U.S. resolve by withholding full compliance. The viability of U.S. strategy – as well as the tactics needed to implement it – thus rest on our assessment of risk preferences in the target regimes. This paper thus presents a model of risk preference as a function of leadership selection effects in unstable political systems, tests this model empirically, and argues from the results that the more unstable the regime, the more likely its leadership will be risk acceptant "high rollers" requiring extraordinary leverage to coerce. The paper then derives implications from these findings for U.S. strategy in the war's coming phases.

Food For Feedback: An Operation Analysts' Reference on Wartime Data Collection

Richard Bird
AF/CVXX, 1570 Air Force Pentagon
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This presentation examines the challenges of fuzing dynamically evolving, nonlinear, complex data into exploitable knowledge. In spite of advances in information technology and knowledge management tools, cultural and organizational bias has allowed military operations analysis feedback processes to languish. Misalignment of knowledge management systems and degenerated crosscutting, comprehensive data collection, management, and exploitation techniques limits warfighters' access to responsive and relevant knowledge of combat operations' effects. Nor are leaders necessarily aware of the importance of exploiting diverse and disparate information sources that should be readily available to them. In recent conflicts, feedback and remedial action has been implemented in after-action reports and lessons learned reports – usually produced late and neither widely read nor internalized. Lessons were "observed," rarely "learned." Designing and developing a comprehensive concept operations and implementing it during an ongoing conflict is the best way to attack this problem.

Current ongoing operations offer fertile opportunity for knowledge management and organizational research. This presentation provides an operations analysts' reference and resource on wartime data collection and operations analysis support to warfighters.

Functional Kill: An Expanded Review of SSBN Vulnerabilities

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Email: duane.boniface@jhuapl.edu

Jonathan C. Bierce
Johns Hopkins University Applied Physics Laboratory
Laurel, MD 20723
Phone: (240) 228-8796, FAX: (240) 228-3044
Email: jonathan.bierce@jhuapl.edu

Even after the fall of the Soviet Union more than a decade ago, the sea-based leg of America's nuclear deterrent triad (the Navy's strategic ballistic missile carrying submarines or SSBNs) continues to be an important foundation upon which the nation's strategic security is built. In the evolving geopolitical order, it can be argued that the primary threat to the United States is no longer direct attack by the nation-state, but rather asymmetric attack from state or non-state actors. Indeed, the

Secretary of Defense recently commented that Sept. 11th shows that "it doesn't take a superpower to take on the United States." The overwhelming superiority of American conventional military forces will continue to drive potential adversaries to explore ways to defuse our strengths through other than direct attacks. As current policy calls upon SSBNs as to be a cornerstone of US strategic security into the foreseeable future, it is reasonable to assume that they may be targeted for asymmetric attack as a part of a more comprehensive strategy.

Western nations traditionally rely upon direct engagement of military forces to achieve war objectives. However, the rest of the world does not necessarily limit their strategic thinking in this manner and may embrace a broader warfare philosophy. Particularly noteworthy in this area is Chinese military thinking, it being the best documented and most mature. Their documentation espoused war fighting methods integrate familiar warfare disciplines such conventional and nuclear, but include also more esoteric forms such as trade, legal, media, ecologic, and network warfare. Such a multifaceted approach has not been experienced by the United States to a significant degree, and vulnerabilities and countermeasure capabilities are not well understood. In an effort to better understand SSBN security in the new strategic environment, the Navy's SSBN Security Program is sponsoring an effort at the Johns Hopkins University Applied Physics Laboratory that will explore force vulnerabilities to a broader (and less traditional) range of threats that may come from unconventional directions. In effect, this is very much along the lines of the Effects Based Operations (EBO) currently under consideration and the subject of a MORS Workshop in January 2002. Offensive utilization of EBO allows the movement from a collection of locally optimal solutions within each facet of coercive diplomacy to a global optimal across these facets. Doing so thus allows users to capitalize upon the various synergies and dynamic responses of a multi-faceted approach. As such, while the larger military community explores the potential of EBO from an offensive perspective, it behooves us to look at our own vulnerabilities to EBO from a defensive perspective. Such is the focus of this effort.

This presentation describes initial efforts to model the functionality of the Navy's strategic weapon system. The project for which this work is being performed is interested in understanding the threats to system functionality from action other than traditional methods of naval warfare (e.g., torpedoes and/or depth charges) Termed the "Functional Kill" project, this current research augments ongoing reviews of threats of and vulnerabilities to direct physical attacks on assets by focusing instead on the dependencies of the SSBN on surrounding infrastructures. Specifically, this research is reviewing those pathways that could lead to a loss of operational capability that do not require the position of the SSBN to be known. Using fault tree analyses, this analysis is structuring and evaluating pathways that could lead to a loss of operational capability, in order to identify, evaluate and recommend countermeasures for the near term.

In addition to this near term review of threats and vulnerabilities, a more detailed and encompassing evaluation is being initiated, as a form of second generation analysis. This analysis will go beyond static fault tree modeling and will explore a broader threat set, to include more of the pathways espoused in the Chinese work. Using more advanced mathematical techniques, such as influence diagramming and various network based approaches, the interdependencies, synergies and non-linearities can be better explored and accounted for, thus more accurately characterizing the true risk to SSBN security. These developing efforts will also be outlined in this summary.

"Strategic Anti-missile Attrition Zone (SAAZ) Defense" - a zone defense concept to meet the ever changing ballistic missile threat to the United States, its allies and friends

Michael A. Bressler
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915-568-2185/2184, bresslermichael@otc.army.mil

The Department last year conducted extensive and rigorous missile defense reviews to determine how best to fulfill the Nation's need to defend the U.S., deployed forces, allies and friends. The findings underscore the importance of layered defenses as well as the need for new approaches to acquire and deploy missile defenses. My objectives are:

- Establish a single program to develop an integrated system under a newly titled Missile Defense Agency (MDA).
- Assign the best and brightest people to this work.
- Apply a capability-based requirements process for missile defense.
- Direct the MDA to develop the missile defense and baseline the capability and configuration of its elements and Military Departments to procure and provide for operation and support.
- The full and cooperative efforts of the Services, Joint Staff, and defense agencies are essential to this goal."

- Donald Rumsfeld, Secretary of Defense (MEMO of 2 January 2002)

This is a concept paper which will do away with conventional thinking and structure a practical approach to the quagmire of uncertainties associated with a national missile defense. It will key into the Defense Secretary's desire to explore new approaches, think beyond the conventional, and attempt "out-of-the-box" vision. It will advance a notion of shared cost - shared responsibility among all the Armed Services making use of all the good and valuable work heretofore accomplished

by an unprecedented Government / Contractor effort. The paper will be an attempt to kick-start thinking and provoke questions in response to the Secretary's 2 January "guidance" memorandum that clearly challenges us all to revitalize our thinking.

The Secretary further underscores the need for both "international participation" and the "Military Departments to provide forces, as needed, to support the fielding of early and/or contingency capability and will budget the resources to procure and operate the planned force structure".

In addition, the Secretary's second of four top priorities makes a point of being able to:
"employ a Ballistic Missile Defense System that layers defenses to intercept missiles in all phases of their flight (i.e., boost, midcourse, and terminal) against all ranges of threats."

The paper will expand on the notion of a zone defense that addresses the above points made by the Secretary. Since the paper is a concept idea only certain assumptions will be made at the onset which adhere to the Secretary's guiding principles. Three of the more important assumptions are:

Assumption #1. That where the missile defense objectives are in conflict with treaty, defense objectives will take precedence. **Assumption #2.** That unconventional thinking will apply to multi-service procurement and where ever possible economy of acquisition and requirements will govern.
Assumption #3. That flexibility will be the hallmark of implementation overriding political bickering and prima-donna attitudes.

The paper will conclude with a hypothetical war scenario taking place in the year 2025 which calls into play a smooth working relationship of all the Services including the U.S. Coast Guard.

Instructable Agents for Strategic Center of Gravity Analysis

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Students at the U.S. Army War College are discovering new insights into Center of Gravity analysis. They both teach and learn from an intelligent agent software program called Disciple, created in the George Mason University Learning Agents Laboratory (LALAB). This paper will describe a multi-faceted research and development effort that synergistically integrates research in Artificial Intelligence, Center of Gravity analysis, and practical deployment of an agent into Education.

USSPACECOM BMD Threat-Mission Study

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The Unified Command Plan (UCP) tasks the United States Space Command (USSPACECOM) to "plan for and develop requirements for strategic ballistic missile defense, space-based support for tactical ballistic missile defense and space operations." USSPACECOM/J5B has the command lead to identify warfighter strategic BMD requirements and inscribe them into the BMD CRD. USSPACECOM/J5B tasked USSPACECOM/AN to assist in providing analytical rigor to support (substantiate and verify) the command's warfighter BMD requirements delineated in the BMD CRD. To satisfy the tasking, USSPACECOM/AN performed analysis to substantiate and verify the missions, roles, architectures, performance requirements, and operational concepts described in the Ballistic Missile Defense (BMD) Capstone Requirements Document (CRD). The background, methodology and the results of this analysis (called the Threat-Mission Study) will be presented

Update on the Weapon Assignment Model (WAM)

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Abstract unavailable at printing.

Analysis of Terrain Effects on a Back-up Fuzing System Utilizing Distance Traveled

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Abstract unavailable at printing.

Maintain Attack Relative Timing

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RISOP Analysis

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Force Structure Analysis in support of the NPR

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Nuclear Stockpile Sizing for the NPR

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Uncertainties and Effects of a U.S. NMD System

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Proxy Weapon Effectiveness

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Abstract unavailable at printing.

Stability Assessment of the 2001 Nuclear Posture Review Strategies

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The status of strategic nuclear forces is changing for both Russia and the U.S. While economic woes plague Russia, strategic system lifetime issues affect both nations, signaling either the development of new strategic systems or lifetime extension programs. For the U.S., the 2001 Nuclear Posture Review (NPR) has established initial directions for the future of U.S. strategic policy. These policy issues were the focus of many working groups providing inputs to the NPR. Many factors affecting the U.S. strategic posture and capabilities are addressed, although strategic stability gets little mention in the NPR. The relative stability of the U.S. with respect to other nuclear capable nations is still of interest, especially given reduced nuclear warhead levels and the expected introduction of missile defenses. The decision to unilaterally reduce to 1700-2200 deployed warheads was influenced by the analysis of several force level and strategy combinations. Using classified sources for U.S. and threat capabilities, the force levels and strategies used for the NPR are evaluated with respect to well known metrics of stability. Using these scenarios as a baseline, limited ballistic missile defense is added to the U.S. strategic force and its effect on stability is examined. This analysis is intended to provide a preview of the stability implications of mutual strategic warhead reductions up to the year 2015.

Mobile Environmental Effects Technology

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Military operations and weapon systems are adversely affected to some extent by the environment, even those advertised as "all weather capable". Thus, it is essential to provide advance warning of these impacts to commanders, and end users, such that intelligent decisions can be made regarding what weapon systems or tactics to employ as well as where and when to employ them. The U.S. Army Research Laboratory (ARL) has developed a number of automated software applications designed to provide environmental information and environmental effects to the end user. Much of this technology has been transitioned to fielded Army automated command and control systems. Recent research has focused on the technology development for mobile computing devices such that lower echelons can eventually have access to this vital intelligence. In addition to an environmental effects application, technology has been developed to provide acoustic propagation effects, weather alerts and even a capability to enter and transmit a local weather observation back to a server. This presentation will focus on the applications that have been developed for the mobile device.

Nuclear Posture Review: Challenges for the MORS Community

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The Department of Defense has outlined in the Quadrennial Defense Review (September 2001) a general approach to transform military strategy. The Nuclear Posture Review (December 2001) provided an additional level of detail for the transformation of the existing deterrence strategy to a broader-based strategy that addresses the new defense policy goals. The operations research community provided the analytic framework for the models and metrics by which the past deterrence strategies were measured. The new strategy outlined in the Nuclear Posture Review is fundamentally different from that of the past and is much more complex. The past strategy was threat-based and dependent on offensive strategic nuclear forces and mutual vulnerability to ballistic missiles; it will be replaced by a new, capabilities-based strategy. The capabilities-based force will be characterized by a significantly reduced arsenal of offensive strategic nuclear weapons which will be part of a "New Triad." The New Triad is comprised of offensive strike capabilities (both non-nuclear and nuclear), defensive capabilities (both active and passive), and infrastructure capabilities (both R&D and production). Improvements in intelligence, planning, and command and control also will be required to provide flexibility and to integrate the capabilities of the New Triad. This new framework will present new challenges and opportunities for the operations research community. New models and metrics will need to be developed to guide the development of the New Triad and to measure its effectiveness. Many details regarding new capabilities, planning systems, and employment concepts remain to be developed. The operations research community will need to play a significant role to provide options to the national leadership in this time of innovative transition. This presentation will provide an overview of the new strategy and will outline the challenges associated with the New Triad concept for the MORS community.

Nuclear/Conventional Weapons Tradeoffs

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Abstract unavailable at printing.

Advanced Analysis/Planning – Object Oriented Design

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High Power Electromagnetic (HPEM) Threat Considerations

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Terrorist events have forced the United States to rethink the exploitation of weapons of mass destruction and high technology weapons. Identification of the threat capabilities of low technology terrorist forces is blurred by the financial ability to purchase high technology weapons. Consequently, some commercial and industrial organizations in the U.S. may not understand the need for or possibility of protecting their information and equipment against the electromagnetic threats.

An exoatmospheric detonation of even a single nuclear warhead could result in a high-altitude electromagnetic pulse (HEMP) having far-reaching effects on unprotected electronic systems without affecting people. Orbiting, air, and ground systems could be affected by this form of HPEM. Non-nuclear sources of HPEM energy could also produce similar effects locally. In either type of HPEM event, it may take hours or even longer before people realize the cause and extent of the resulting equipment malfunctions.

The frequencies and intensities of signals coupled into systems from various HPEM threats are similar in many ways. Hardening systems against the effects from both sources at the same time prevents unbalanced hardening, unnecessary hardening overlap, and reduces hardening and sustainment costs. Actions can be taken to increase the protection of U.S. commercial and military interests. This paper will explore some of the effects of nuclear and non-nuclear HPEM. Lessons learned in test and survivability evaluation of Army systems will be presented along with protection solutions ranging from design considerations to simple steps.

NBC Defense WG-2

Chair: David W. Evans, ANSER
Co-chairs: Karsten G. Engelmann, Center for Army Analyses
J. Krause Wilson, Innovative Emergency Management, Inc. (IEM)
Advisor: Michael Kierzewski, Optimetrics
GIF 351B

The following abstracts are listed in alphabetical order by principal author.

Radioprotectant Pharmaceuticals: Force Protection in the Post Nuclear Environment

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The post nuclear environment would include exchange of weapons, terrorist use of " dirty" conventional bomb, or a reactor accident. Radioprotectant pharmaceuticals include pre-treatment and immediate post-exposure treatment that can mitigate symptoms and cytotoxic effects, including chromosomal damage and long term sequelae. Some of these pharmaceuticals are FDA approved today for radiation therapy use, and granisetron, has a sanctioned military use and dose pack. Research projects underway at the Armed Forces Radiobiological Research Institute (AFRRI) and discussed in a recent DOD, NCI, NIH Interagency Workshop "Molecular and Cellular Biology of Moderate Dose Radiation and Potential Mechanisms of Radiation Protection" promise substantial enhancement of the generally considered LD_{50} doses used in consequence models today. This paper would summarize this research and propose operational scenarios, pretreatment of military members, and stockpiling of radioprotectant pharmaceuticals.

Sensitivity Analysis of a Manual Decision Support Tool for Making Protective Action Decisions for the Public

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This paper presents the results of a sensitivity analysis performed on a protective action recommendation algorithm developed to aid decision-makers in the event of a chemical stockpile emergency involving the release of chemical agent into the atmosphere. The development of the decision algorithm via QEM-World® and the design of the sensitivity analysis are discussed. The design involved an examination of the effects of the following factors on the output of the algorithm and on risk to the community surrounding the chemical stockpile site: emergency response characteristics, warning diffusion properties, public response characteristics, indoor air exchange rates, breathing rate and agent toxicity. The analysis revealed that changes in warning diffusion and agent toxicity assumptions were associated with the largest changes in the algorithm output, while toxicity and breathing rate assumptions exerted the largest effects on the risk to the community. Implications for application of the guidebook methodology to the post-9/11 environment are discussed.

Cryogenic Abatement of Spill-Induced Toxic Vapor Plumes: A feasibility study

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The remediation of volatile toxic liquid spills and abatement of toxic plumes is of increasing concern. Current methodology for emergency remediation of chemical spills usually involves evacuation plus the use of physical methods, such as barriers (dikes) and absorption using clay and removal with heavy equipment, and when applicable, bioremediation methods or chemical methods are used to neutralize the spilled chemical. Only in recent years has frozen soil barrier

technology been used for environmental remediation of contaminated soil. None of the current methods immediately and specifically address the abatement of the vapor plume induced by the chemical spill. The feasibility study, by using calculated estimates and computer modeling, indicates that the use of inexpensive cryogenic liquids such as liquid nitrogen (LN2) shows promise in the abatement of toxic volatile materials spilled as liquids into the surface layer. Chilling and/or freezing of the spilled chemical at the surface minimizes the evaporation and diffusion of the liquid (or sublimation of solid), and therefore, the plume concentration and volume. Introduction of spray (water or other liquid) into the plume to directly washout the chemical and to form a frozen, impermeable crust on top of the spill area may further reduce the plume concentration and volume.

A Simple and Fast Method for the Estimation of the Utility of Various Mixes of Fixed and Mobile Point Biological Agent Detector Systems

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The evaluation of complex mixes of fixed and mobile point detection systems is difficult due to the many issues affecting their utility. Key issues include the number of fixed and mobile detectors, the size of the protected area, detector operation (detection cycle time, movement and setup time), false alarm rate, number of simultaneous detections required, and threat (detectable cloud size and duration). The method was constructed to complement a complex Monte Carlo class model (STAFFS – Simulation Training and Analysis for Fixed Sites) used to evaluate a wide range of detector mixes, operational concepts, target sizes, weather, and threats. Detailed Monte Carlo-type methods involve complex data streams and long execution times that limit the number of cases that can be examined. The simple method allowed a wider range of cases to be examined (albeit at a lower level of resolution) so that key sensitivities could be established and used to reduce the case matrix of the complex model. The simple method also permits an analyst to quickly discover fundamental relationships between overall system performance and detector characteristics, The method uses a simple binomial algorithm to combine detection probabilities for individual detectors.

Assessment of CW on Airbase Operations

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Recent studies and analysis have challenged many historical assumptions concerning airbase operations in a chemically contaminated environment. Studies revealed that with revised CONOPS and procedures, combat sortie generation activities could resume quicker and safer. Previous Air Force sortie degrade inputs to the QDR were in excess of 40% and subsequent J8 WMD studies reported a 25-30% degrades. These operationally unacceptable degrades subsequently initiated a series of studies and live-agent testing, resulting in the Air Force re-examining hazard duration values previously used and re-defining airbase chemical warfare operational environment. Analysis conducted using the re-defined understanding of the airbase specific environment has shown that there are opportunities to significantly increase operational capability through changes in CONOPS and procedures.

The current analysis reflects the impact of these refined C-CW CONOPS on the ability to significantly recover sortie generation combat power in a CW environment. It quantifies the contribution of functional components to the overall sortie generation degrade, and the recovery possible by implementing the revised C-CW CONOPS. Analysis was conducted using Expediter, and AF/XONP model. It is an event driven, intelligent agent simulation that allows for realistic interactions between airbase functional systems, down to the individual asset level. This analysis identifies key operational vulnerabilities and possible mitigation strategies that could minimize these vulnerabilities and maximize the operational capability of the base.

The results of the analysis indicate that the procedures developed in the C-CW CONOPS, tailored to each specific location and mission, can improve sortie generation rates by up to 30%. The revised sortie generation degrades provided to the QDR CIWG were between 5% and 15% (varied by base), significantly lower than traditional assessments.

The Modified Covering Problem on Paths and Trees

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The Modified Covering Problem (MCP) is introduced as a subset of the Set Covering Problem (SCP). The MCP seeks to minimize the number of uniform-capability, uniform-cost facilities required in order to cover all demands with the requirement that a demand cannot be covered by a collocated facility. The motivations for the MCP include two categories of applied problems: when a facility cannot serve a demand as its own location and when a facility has both a minimum and a maximum covering radius. One example in the first category is the location of the Weapons of Mass Destruction Civil Support Teams, as an NBC strike may disable them from responding to their own city.

The MCP is then formulated as a binary integer program. A polynomial algorithm is developed for solving the MCP on paths with uniform link distances, and solving within 20% of optimality on paths with non-uniform link distances. Next, an exponential algorithm is developed to solve non-uniform link distance problems to optimality. Finally, an algorithm is shown to develop strong upper and lower bounds for the optimal solution on trees with non-uniform link distances. Continuing efforts focus on developing a polynomial algorithm for non-uniform link paths.

Protective Action Decision Making Using D2-PuffTM and SafePortTM

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Choosing a protective action (evacuate or shelter) for the general public in the event of a chemical agent release can be complicated. The correct protective option changes with the type of hazard, the time available to respond, weather forecasts, conditions in the community, and a host of other factors. Emergency management decision-makers can, at the same time, be overloaded with information and not have access to the proper information to make a good decision. D2-Puff™ and SafePort™ provide emergency managers the ability to store and analyze this critical information and use it effectively in an emergency.D2-Puff™ is an advanced dispersion model developed by IEM that draws a picture of the most likely path of the toxic cloud or "plume," based on the hazardous substance's properties and the local weather conditions. D2-Puff™ fully accounts for the way in which changes in the weather over time affect the shape and severity of the plume, giving analysts a more realistic picture of the hazard. D2-Puff™ also models dispersion over complex terrain and processes weather data from the Internet. SafePort™ is a computer-based expert decision support system that can be adapted to a wide variety of hazards. SafePort™ accounts for specifics of the local plans and procedures, sociological responses, and community and traffic conditions. It generates the protective action recommendations that provide the greatest protection for populations affected by the unfolding scenario. SafePort™ considers the current situation with regard to demographics, sociological factors, roadway characteristics, and hazard information. This presentation will address the use of D2-Puff™ and SafePort™ in an operational setting and from a modeling standpoint. The impact of the stored data on the output will be discussed as well as an overview of how these two tools used in conjunction can enhance the safety of the general public.

Biological Warfare Amateur Methodology

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We have estimated the likelihood that small groups of true "amateurs" could successfully devise a competent biological weapon and execute an attack, in the absence of state program support, using only open-source information. This study began in July 1999 and continued through Feb, 2002 and involved >150 individuals comprising >30 small groups spanning a broad range of educational level, technical expertise, work experience, and age.

Weapons of Mass Destruction -- Impact on Army Operations

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Recent WMD studies have focused on the effects at specific nodes during force projection or during offensive/defensive operations in-theater. These studies are stand-alone and not linked to provide a comprehensive assessment of the effects on the Army across the spectrum of operations and across lines of communication. This study examined previous studies to determine: Army WMD vulnerabilities during the Mobility, Deployment and Employment phases of Force Projection; planning guidance to reduce impact on operations by threat use of WMD to deny or limit LOCs; provide insights and recommendations for changes in WMD defense to reduce vulnerabilities. Analysis methodology is described and results are shown.

Southwest Asia Near Year Analysis (SWANY) Chemical Excursion

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This study examines the use of chemical weapons against US ground forces in the context of CENTCOM's current operational plan (OPLAN) for Southwest Asia (SWA). The sponsor of this study, ARCENT, requested that an excursion be conducted separately from CAA's ground campaign analysis of the current year OPLAN. The chemical excursion analyzes the impact of a theater ballistic missile (TBM) and ground campaign where chemical weapons are used against US ground forces. The intelligence community estimated threat stockpile was allocated to delivery systems and a TBM campaign was conducted using the Extended Air Defense Simulation Model (EADSIM) and the Post Engagement Ground Effects Model (PEGEM) and the ground campaign was conducted using the TACWAR theater simulation. The effectiveness of the threat's chemical campaign was analyzed and operational planning considerations, based on the results of the chemical excursion, were provided to ARCENT.

Joint Integrated Combat Model (JICM) NBC Module Design and Development

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The Joint Integrated Combat Model (JICM) is a low-resolution, expected value, theater-level model. In order to streamline campaign analyses, the development of the JICM NBC module was required to minimize off-line processing and the associated overhead of shadowing the campaign in TACWAR. NBC effects addressed are: the physical properties and characteristics of agents (from a VLSTRACK-based database); effects of people (including Mission Oriented Protective Posture degradation); effects on equipment and terrain; NBC Warning and Reporting; and, decontamination. Design and development methodology is described and results are shown.

Military Installations Worldwide -- Antiterrorism and WMD

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Foot and Mouth Disease: Should the U.S. Army be concerned?

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This study examines the potential impact on military readiness because of major livestock epidemic in the United States. The study focuses on the potential for foot and mouth disease (FMD) to infect U.S. livestock and the resultant impact on the

readiness of the US Army deployment and training readiness. It uses, as a recent example, the outbreak of FMD in the UK and the use of military personnel to assist with the mitigation of FMD and also impacts on training estates. UK military readiness was impacted in several different ways during this outbreak. The study then uses the UK example and applies potential outbreaks to the regions of the US containing US Army installations collocated with the dense livestock populations. Analysis involves such modeling tools such as ESRI's ARCVIEW and USDA/APHIS "SpreadModel".

A Model for a Federal Role in the Consequence Management Preparedness of State and Local First Responders

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The mission of the Office of Homeland Security will be to develop and coordinate national efforts to prepare for and mitigate the consequences of a terrorist attack. To do this, the Office will coordinate local response plans and exercises and coordinate training for federal, state, and local first responders. This symposium presents a model for a federal roles in the consequence management preparedness of state and local first responders. The model design is based on a successful program that FEMA operates for the Army. The program, the Chemical Stockpile Emergency Preparedness Program, or CSEPP, enhances the preparedness of local responders and offers a tested model for delivering federal assistance and guidance to state and local agencies. Federal funding is based on the varying needs for critical items (such as protective equipment and response plans) of the states and local communities.

Characterization of Fighter Base and APOD Operations for Biological Defense

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As part of the ongoing RestOps Advanced Concept Technology Demonstration (ACTD), a set of "table-top" exercises are being conducted in order to enhance the base's ability to respond to biological attacks. In this presentation, we describe the methods and tools used to provide analytical support to these exercises. This includes the use of NBC dosage and casualty models, the spatially-dependent base population, and the characterization of fighter base and APOD operations.

Effectiveness Criteria for the RestOps CB Defense Situational Awareness Tool

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An assessment of capabilities for the Restoration of Operations (RestOps) Advanced Concept Technology Demonstration (ACTD) led to the need for an IT-based system for Chemical and Biological (CB) Defense situational awareness at the candidate military base. A necessary part of development and deployment of such a system is the development of effectiveness criteria for judging the system's utility. The effort has been nontrivial, since military systems whose goal is to transmit, disseminate or display information for the purpose of decision-making often defy the use of conventional effectiveness criteria. In this presentation we describe the RestOps CB situational awareness tool, its use at Osan AB, and the effectiveness criteria that have been developed to evaluate the system.

Comparison and Analysis of Medical Courses of Action in the NBC Environment

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The Nuclear, Biological, and Chemical Casualty Resource Estimation Support Tool (NBC CREST) supports deliberate medical planning in an iterative, integrated process for US Army medical planning at the Corps, Division, and Corps Medical Brigade levels. The Course of Action (COA) Comparison module of NBC CREST compares and ranks alternative medical COAs to identify the best medical course of action. The comparisons are based upon Deployment, Disposition, and Utilization (DDU) criteria for a user-defined, nuclear, biological, or chemical casualty scenario. Deployment is defined as the medical footprint or the combined total number of MTFs and medical personnel deployed to meet the estimated resource demands of treating the patient stream. Disposition represents the end state disposition of each patient who receives medical treatment. Patients Die of Wounds (DOW), Return to Duty (RTD), or are Evacuated Out of Theater. Utilization reflects the resource usage linked to individual MTFs composing the deployeds medical network. Resources include Beds, Personnel, Class VIII Materiel, and Evacuation Assets. The DDU criteria are weighted according to the specific mission goals and commander intent. As events change users are able to redefine the level of importance placed on each of the DDU criteria by simply modifying default values used in the comparison evaluation. Under each of the three major criterions a sub-category breakdown is provided allowing for ranking of individual factors that compose the overall criteria, including two types of comparison algorithms. The NBC CREST is currently being developed in conjunction with the Army Office of the Surgeon General (OTSG).

Magnus Rotor Bomblet and Spherical Submunition Aerodynamic Thermal Demise

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Evaluating the effectiveness of submunition missile designs requires predicting where surviving submunitions will impact the ground relative to defended assets. Traditionally, surviving submunitions referred to those that continue functioning after a hit-to-kill or fragmenting warhead missile intercept. However, for high altitude or early releases, submunitions must also survive aerodynamic thermal heating. This paper discusses the aerodynamic thermal demise analysis performed for two common ballistic missile submunition designs: 1) a smooth spherical submunition that is often referenced as a chemical bomblet and 2) a Magnus rotor, biological bomblet that has vanes on the surface that spins the submunition when moving through the atmosphere. Release conditions were derived from typical ballistic missile trajectories compiled from the Ballistic Missile Reference Document. The release conditions at which these typical submunitions are all likely to survive or are all likely to demise are discussed. Implications of analysis may show the value or disadvantage in terms of ground effects of engaging submunition threats at high altitude or early in flight. The analysis was performed using the Post-Engagement Ground Effects Model (PEGEM) Version 4.1, which employs submunition dispersion, propagation, and aerodynamic thermal demise modules. Sponsored by the Missile Defense Agency, PEGEM provides a comprehensive tool for assessing the effectiveness of weapon and interceptor systems in terms of ground effects for chemical and biological missile defense. PEGEM submunition modules propagate submunitions throughout their trajectory with a high-order, quick running, three degree-of-freedom numerical integration routine that incorporates aerodynamic coefficients representative of submunition and drag augmentation designs. The aerodynamic thermal demise model is based on stagnation point heat transfer in dissociated air as applied to reentry body nose-cone heating with the addition of radiant cooling effects.A Quantitative Analysis on the Operational Impact of Using Acute Exposure Guideline Levels versus Dosage Levels in Making Protective Action Decisions for the Public.

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In order to enhance public safety surrounding the Chemical Stockpile Emergency Preparedness Program (CSEPP) sites in the continental U.S., the U.S. Army has changed the policy that determines how exposure to chemical warfare agents is determined. Previously, a simple integral of the concentration over time was used to determine if the population exposed to agent exceeded certain dosage thresholds (No Effects, No Deaths, and 1% Lethality). The Environmental Protection Agency (EPA) has adopted a different standard called Acute Exposure Guideline Levels that is based on duration of exposure to critical concentrations. The Army has determined this approach to be better as well. The approach more accurately determines what the medical impacts exposed populations might have due to the agent by taking into account not only the amount of exposure, but the rate at which the population was exposed. The analysis presented here will illustrate some of the operational impacts that this transition will have on the CSEPP communities using a risk-based simulation suite.

Arms Control & Proliferation WG-3

Chair: Tom McIlvain, US Department of State (AC/ST)
Co-chairs: Rachel Echternach, USSTRATCOM/J533
Advisor: Dr. Robert Batcher, US Department of State (VC/TA)
GIF 351A

The following abstracts are listed in alphabetical order by principal author.

Is it Time for Strategic Stability Measures to Evolve or Disappear?

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Abstract unavailable at printing.

Optimal Strategies for Multipolar Nuclear Warfighting

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The objective is to determine allocation of the weapons of three sides to counterforce, countervalue and withhold in a three-stage nuclear war. The factors considered are number of weapons, number of weapons that are vulnerable, number of value targets, and counterforce and countervalue effectiveness. A utility measure is proposed which reflects forces and value surviving at the end of the three-stage war. A robust strategy is identified for the first striker that does not depend on which sides strike second or third. Optimal strategies are identified for the second and third strikers.

For representative forces insights are developed as to: (1) how each side would fare depending on the order of strikes and (2) how each side should allocate his weapons at each stage. Stability metrics are proposed and applied. The impact of defenses is investigated.

The Selection of Sites for Chemical Weapons Inspection

Dr. James Bradley
US Department of State VC/TA

The Chemical Weapons Convention was ratified in 1997. One of its provisions mandated a regime of inspections of a particular class of chemical plants to begin in 2000. However, the treaty did not specify exactly how sites were to be selected other than saying that the selection should be "random." This presentation will discuss a methodology the United States has advocated for site selection and will discuss progress that has been made toward its adoption by the OPCW.

Structural Factors Shaping the Indo-Pakistani Conflict

Dr. Dan Geller
University of Mississippi

This study explores the structural factors associated with the Indo-Pakistani conflict. Although every conflict between nation-states has its unique elements, it has been shown that the presence or absence of certain structural factors increases the probability of violent interaction. Recent scientifically oriented meta-analyses have identified a list of such factors based on an examination of hundreds of quantitative empirical studies of international conflict analyzing patterns of war from the beginning of the nineteenth century through the end of the twentieth century. The objective of these meta-analyses is to produce a scientific explanation of war that would account for historical wars as well as provide a means for estimating the likelihood of future conflicts. This study examines the conflict between India and Pakistan from the perspective of those factors that have shown consistent correlation with the onset of war. The factors brought to bear in the analysis include geographical contiguity, form of government, level of economic development, the conventional and nuclear capability balance, and the presence of an enduring rivalry between India and Pakistan. Each of these factors has been shown to influence the probability of conflict between states. The concluding section of this study places these structural forces within the context of future Indo-Pakistani relations.

Implications and Issues of Expanding the Inactive Nuclear Stockpile

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Abstract unavailable at printing.

NPR and Stockpile Life Extension

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Abstract unavailable at printing.

Nuclear Stability and Sufficiency Today

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During this period of transition from the Cold War, what are the key issues of nuclear stability and sufficiency? Issues extracted from current nuclear policy literature and Administration policy papers are reviewed in the context of general concepts of stability and control theory. The author argues that multiple failure modes should be looked at in combination since coupling among different instability modes is often a problem and that size matters –stability cannot be separated from sufficiency. He also proposes some guidelines for evaluating force postures and finds that non-strategic nuclear weapons may be more relevant than strategic nuclear weapons in maintaining stability in relevant contingencies.

Quantitative Aspects of Growth in Nuclear Warhead Stockpiles

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Abstract unavailable at printing.

Bridging the Gap between Quantitative and Qualitative Analysis: A Framework using Nuclear Triangles

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Most analyses of stability concepts deal exclusively with quantitative stability metrics or exclusively with qualitative stability concepts. Very few attempt to span the gap and link both quantitative and qualitative concepts to provide richer insights into stability dynamics. This presentation outlines a hierarchy of stability concepts, both quantitative and qualitative, and applies the stability concepts to a network of countries using "nuclear triangles." The nuclear triangles methodology analyzes the stability dynamics of sets of three countries at a time and thereby builds a display of the interlocking stability relationships. The stability framework and triangles methodology presents a way to convey both quantitative and qualitative metrics into an integrated presentation of stability characteristics. The presentation uses this methodology to survey the challenges of the present geopolitical environment.

All Our Tomorrows: A Long-Range Forecast of Global Trends affecting Arms Control Technology

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This report summarizes a three-phase research project undertaken by the USAF Institute for National Security Studies on behalf of the Defense Threat Reduction Agency to forecast long-range global trends affecting arms control technologies. The report projects the international political, economic, and scientific environments to the year 2015. It posits economic and technological drivers as shaping the system, including its military and political dimensions. The result will be a two-tiered system, with great danger arising from significant proliferation in the second tier and the transition zone between tiers. The report next draws conclusions from this likely future for the scope, value, and practice of arms control. Arms control will be focused less on limitation and reduction of existing weapons, although the endgame there between the US and Russia will remain a significant effort. The focus will shift to the less well-defined realm of counter-proliferation, and to marginal, failing and failed states as well as non-traditional and non-state actors. New dimensions will be added, including control efforts toward small arms, advanced conventional weapons, military space, and information operations. The report then extrapolates from this future to assess the likely arms control technology requirements in cooperative, non-cooperative, intrusive, and non-intrusive regimes. The projection here is continuing requirements for each of these specialized sets of technologies, with particular emphasis on multiple-use technologies fro remote arms control compliance and verification monitoring as well as for intelligence detection and collection. Similarly, area arms control monitoring systems must be capable of application for force protection applications. Data Management/knowledge management will become a top priority for arms control, as will the continuing development of human expertise in this advanced area of specialization.

Lessons Learned from U.S. Counterproliferation Counterforce Operations

Dr. Forrest Waller

Abstract unavailable at printing.

Air and Missile Defense WG-4

Chair: Bob Strider, US Army Space and Missile Defense Command
Co-chairs: Tom Denesia, NORAD-Peterson AFB
Dr. Richard Goodwin, Logicon
Christopher Jones, Computer Systems Center, Inc.
Robert Koury, Lockheed Martin Corp.
Jim Schlichting, US Army Space Command
Dr. Nigel Siva, SPARTA
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Strategic Anti-missile Attrition Zone (SAAZ) Defense

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" The Department last year conducted extensive and rigorous missile defense reviews to determine how best to fulfill the Nation's need to defend the U.S., deployed forces, allies and friends . The findings underscore the importance of layered defenses as well as the need for new approaches to acquire and deploy missile defenses. My objectives are:

- Establish a single program to develop an integrated system under a newly titled Missile Defense Agency (MDA).
- Assign the best and brightest people to this work.
- Apply a capability-based requirements process for missile defense.
- Direct the MDA to develop the missile defense and baseline the capability and configuration of its elements and Military Departments to procure and provide for operation and support.
- The full and cooperative efforts of the Services, Joint Staff, and defense agencies are essential to this goal."

- Donald Rumsfeld, Secretary of Defense (MEMO of 2 January 2002)

This is a concept paper which will do away with conventional thinking and structure a practical approach to the quagmire of uncertainties associated with a national missile defense. It will key into the Defense Secretary's desire to explore new approaches, think beyond the conventional, and attempt "out-of-the-box" vision. It will advance a notion of shared cost - shared responsibility among all the Armed Services making use of all the good and valuable work heretofore accomplished by an unprecedented Government / Contractor effort. The paper will be an attempt to kick-start thinking and provoke questions in response to the Secretary's 2 January "guidance" memorandum that clearly challenges us all to revitalize our thinking.

The Secretary further underscores the need for both "international participation" and the "Military Departments to provide forces, as needed, to support the fielding of early and/or contingency capability and will budget the resources to procure and operate the planned force structure".

In addition, the Secretary's second of four top priorities makes a point of being able to:

"employ a Ballistic Missile Defense System that layers defenses to intercept missiles in all phases of their flight (i.e., boost, midcourse, and terminal) against all ranges of threats."

The paper will expand on the notion of a zone defense that addresses the above points made by the Secretary. Since the paper is a concept idea only certain assumptions will be made at the onset which adhere to the Secretary's guiding principles. Three of the more important assumptions are:

- Assumption #1. That where the missile defense objectives are in conflict with treaty, defense objectives will take precedence.
- Assumption #2. That unconventional thinking will apply to multi-service procurement and where ever possible economy of acquisition and requirements will govern.
- Assumption #3. That flexibility will be the hallmark of implementation overriding political bickering and prima-donna attitudes.

The paper will conclude with a hypothetical war scenario taking place in the year 2025 which calls into play a smooth working relationship of all the Services including the U.S. Coast Guard.

Assessing Potential Next Generation Kill Vehicles for the BMDS

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Abstract unavailable at printing.

Combat Identification (CID) Vignette Tool

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Despite a general recognition of the importance of CID in military operations, few modeling tools make much of an effort to represent the CID process. Those modeling tools that do address CID typically treat only a limited portion of the problem. For example, most models currently divide the problem into only two types of targets – friends and hostiles. However, there is a requirement that real world operations must perform discrimination between friends, hostiles and neutrals. Because the Joint Theater Air and Missile Defense Organization (JTAMDO) was tasked to assess CID requirements, JTAMDO needed an analytical tool to facilitate its evaluations. The limitations of current models led JTAMDO to sponsor the development of a new analytical tool that could evaluate both current and possible future CID operations.

The JTAMDO sponsored CID model is called the Vignette Tool (VT) because it evaluates the ability of the family of blue systems to develop target identification against a single target at a time. Repeated runs of the VT allow one to evaluate the CID process throughout an entire theater. The VT supports evaluations of multiple types of targets, ID sensor fusion techniques, levels of ID sensor performance, etc. The VT provides tabular and graphical outputs of the probability of correctly and incorrectly declaring IDs as targets progress through a theater. This presentation describes the numerous capabilities included in the VT.

Probability of Designation of a Warhead in a Threat Cloud

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An important measure of effectiveness for the Ballistic Missile Defense System (BMDS) is the area over which that system achieves a given *Probability of Engagement Success* (PES) against each missile in a raid of a given size. For BMDS concepts engaging in midcourse using off–board sensors for data collection and homing kill vehicles for target destruction, the PES may be estimated as the product of relevant availabilities and reliabilities of the elements and the probabilities of success in each of the engagement functions: *Detection*, *Track [and Correlation]*, *[Resolution and] Discrimination, Handover (Seeker Acquisition and Kill Vehicle Divert), Designation, and Hit.* The *Probability of Designation* as the probability that the kill vehicle can find, among the many objects that may surround the target, the one that the external sensors have identified for it. This paper derives the *Probability of Designation* under these general assumptions: the warhead is in a cloud of objects with a specified distribution of drift velocities in three dimensions, the on–board sensor and seeker errors are normally distributed, and the engagement geometries are known. The paper shows how, for the special case of spherical drift rates and spherical track errors, a map of the probability of designation can be generated rapidly for different times since object release and for different sizes of the track error, without the necessity of many time–consuming numerical integrations or Monte–Carlo runs.

An Analysis of Engagement Coordination Methodologies of Aegis Platforms

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As both communications bandwidth increases and computing capability continues to become more sophisticated, the ability to share information and resource states across platforms in real time becomes more realizable. Thus, the potential for a complete realization of the vision of Network Centric Warfare comes closer to reality. With these advances and the constantly evolving, more dangerous threats, the need for multi-platform Distributed Weapon Control (DWC) becomes inevitable. DWC consists of three components, namely, Threat Assessment, Sensor Coordination and Engagement Coordination. Engagement Coordination is the utilization of forces, networked information and resources in a more effective way to defeat the enemy and is the topic of interest in this brief.

The High Performance Distributed Computing (HiPer-D) laboratory is a real-time laboratory located in Dahlgren Virginia where multiple Aegis tactical system platforms are prototyped in order to demonstrate proofs of concepts with respect to advanced computing architecture and algorithm development. There it was shown that a multi-objective algorithm could make a decision in a tactical environment in real-time by sharing fire control information across Aegis platforms. The next phase was to show value added to the battlegroup. This brief describes the current Engagement Coordination schemes in the Navy Fleet today. It then demonstrates through modeling how using shared high fidelity fire control information, platform state information across platforms and a multi-objective decision algorithm can improve battlegroup effectiveness. The focus of this brief is to show the value added using a multi-objective decision algorithm to select the shooter over the current Engagement Coordination schemes used in the Navy fleet today. Additional discussion includes how this methodology can be extended to other, non-Aegis platforms due to the generic criteria and required interfaces.

Operational Contributions of Space Systems WG-5

Chair: Steve Friedman, Veridian
Co-chairs: Capt Jeff DelVecchio, SMC/XRDM
Maj Tim Gooley, SWC/XRC
Steve Pierce, USA SMDC
Mark Reid, Applied Research Associates
Advisor: LtCol Suzanne Beers, SMC Det 11
Bell Hall 20A

The following abstracts are listed in alphabetical order by principal author.

Air Force Satellite Control Network (AFSCN) Scheduling

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The Air Force Satellite Control Network (AFSCN) is a global, ground - based configuration of satellite command, control and communications resources dedicated to supporting our nation's space program (i.e. Department of Defense and other assigned space missions). The AFSCN coordinates the use of fifteen common user Automated Remote Tracking Stations antennas to support over 100 on-orbit satellites. Each satellite has a required number of contacts per day and duration of each contact. Also, the satellites' known orbits predetermine their visibilities with each of the antennas. This large number of current resources, the constantly expanding role of space in military operations, and National policy issues make the management of these resources an increasingly complex issue.

The 50th Space Wing (50 SW) operates and manages all AFSCN resources. In order to deal with the growing complexity, the Directorate of Plans and Programs 50SW would like a planning tool to answer resource allocation questions. For example, do we have enough ground equipment to support current and future on-orbit satellites? Where should we locate future ground systems to support the satellites? What are feasible locations if the AFSCN has operational restrictions in the CONUS?

Several efforts (by Gooley, Schalck, Burrowbridge *et al*, and Crowder and Mehlberg) have produced excellent results where specified scheduling requests are input by each satellite program. Yet there has been little work done on a less restricted problem, where satellite managers request only frequency, separation, and duration of satellite supports.

We model this problem as a scheduling problem where we allocate antennas to satellites. We exploit the problem structure to create tractable optimization models.

The Ground Moving Target Indicator (GMTI) Analysis of Alternatives (AoA) Accreditation Process

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The GMTI AoA is being conducted by the Air Force Space Command (AFSPC) Space Analysis Center (ASAC) to support AFSPC/DR in their requirements definition process for the acquisition of a space-based radar, or an equivalent technology, that will provide GMTI information to the combatant commands. The AoA will use a number of models and simulations to assess the military utility of each of the alternatives. In order for the decision-makers to have confidence in the results produced by the M&S, and ultimately the AoA, an accreditation is being accomplished to judge if the models are "good enough" to support the required decisions. The accreditation process defined for this AoA is the first-ever conducted by AFSPC, and will serve as the pathfinder for future AoA's conducted by the ASAC for the Command's decision-makers. This presentation will describe that accreditation process and the specifics of the plan set forth for the accreditation of the models to be used for the AoA.

Strategic Anti-missile Attrition Zone (SAAZ) Defense

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" The Department last year conducted extensive and rigorous missile defense reviews to determine how best to fulfill the Nation's need to defend the U.S., deployed forces, allies and friends . The findings underscore the importance of layered defenses as well as the need for new approaches to acquire and deploy missile defenses. My objectives are:

- Establish a single program to develop an integrated system under a newly titled Missile Defense Agency (MDA).
- Assign the best and brightest people to this work.
- Apply a capability-based requirements process for missile defense.
- Direct the MDA to develop the missile defense and baseline the capability and configuration of its elements and Military Departments to procure and provide for operation and support.
- The full and cooperative efforts of the Services, Joint Staff, and defense agencies are essential to this goal."

- Donald Rumsfeld, Secretary of Defense (MEMO of 2 January 2002)

This is a concept paper which will do away with conventional thinking and structure a practical approach to the quagmire of uncertainties associated with a national missile defense. It will key into the Defense Secretary's desire to explore new approaches, think beyond the conventional, and attempt "out-of-the-box" vision. It will advance a notion of shared cost - shared responsibility among all the Armed Services making use of all the good and valuable work heretofore accomplished by an unprecedented Government / Contractor effort. The paper will be an attempt to kick-start thinking and provoke questions in response to the Secretary's 2 January "guidance" memorandum that clearly challenges us all to revitalize our thinking.

The Secretary further underscores the need for both "international participation" and the "Military Departments to provide forces, as needed, to support the fielding of early and/or contingency capability and will budget the resources to procure and operate the planned force structure".

In addition, the Secretary's second of four top priorities makes a point of being able to: "employ a Ballistic Missile Defense System that layers defenses to intercept missiles in all phases of their flight (i.e., boost, midcourse, and terminal) against all ranges of threats."

The paper will expand on the notion of a zone defense that addresses the above points made by the Secretary. Since the paper is a concept idea only certain assumptions will be made at the onset, which adhere to the Secretary's guiding principles. Three of the more important assumptions are:

Assumption #1. That where the missile defense objectives are in conflict with treaty, defense objectives will take precedence. **Assumption #2**. That unconventional thinking will apply to multi-service procurement and where ever possible economy of acquisition and requirements will govern. **Assumption #3.** That flexibility will be the hallmark of implementation overriding political bickering and prima donna attitudes.

The paper will conclude with a hypothetical war scenario taking place in the year 2025 which calls into play a smooth working relationship of all the Services including the U.S. Coast Guard.

USSPACECOM BMD Threat-Mission Study

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The Unified Command Plan (UCP) tasks the United States Space Command (USSPACECOM) to “plan for and develop requirements for strategic ballistic missile defense, space-based support for tactical ballistic missile defense and space operations.” USSPACECOM/J5B has the command lead to identify warfighter strategic BMD requirements and inscribe them into the BMD CRD. USSPACECOM/J5B tasked USSPACECOM/AN to assist in providing analytical rigor to support (substantiate and verify) the command’s warfighter BMD requirements delineated in the BMD CRD. To satisfy the tasking, USSPACECOM/AN performed analysis to substantiate and verify the missions, roles, architectures, performance requirements, and operational concepts described in the Ballistic Missile Defense (BMD) Capstone Requirements Document (CRD). The background, methodology and the results of this analysis (called the Threat-Mission Study) will be presented.

US Army Space Modeling and Simulation (M&S) Focus Area Collaborative Team (FACT)

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The Army Space Modeling & Simulation (M&S) Focus Area Collaborative Team (FACT) was convened in response to a Department of the Army, Deputy Chief of Staff for Operations and Plans (DA-DCSOPS) tasker directed by the Vice Chief of Staff Army (VCSA) during the Space Force Management Analysis (FORMAL) Review on 4 September 2001. The Space FORMAL Review recognized that Army Space requirements and capabilities are not captured in current models and simulations. As a result, there are no robust analyses to support space acquisition and develop space requirements. The members of the review also noted that the training of space battle staffs is lacking. The Space M&S FACT is to present a coordinated space M&S roadmap recommendation to the Army Models and Simulations Executive Council (AMSEC) during their Fall 2002 meeting.

SBIRS Increment 1: An Initial Look at the Results of Fusing Space-Based Infrared Data at the Mission Control Station

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Declaration of Initial Operating Capability (IOC) for Increment 1 processing of DSP data at the SBIRS Mission Control Station (MCS) occurred in mid-December 2001. SBIRS Inc. 1 processing delivers significant improvements for strategic/space launch and in-flight parameter estimates as a result of fusing available space-based infrared (IR) data. This type of fused data product has been providing enhanced warning of theater launch data since the early 1990s when ALERT (Attack and Launch Early Reporting to Theater) was formed to provide more accurate, timely launch data to the theater. This capability has been extended to strategic and space launch events with SBIRS Increment 1 processing.

The SBIRS MCS started Initial Operations Evaluation & Testing (IOT&E) in early June 2001. Since mid-September 2001, strategic and tactical missile launch messages from the MCS have been available to forward users via their respective broadcasts. In the Analysis Directorate at HQ NORAD/USSPACECOM, we have been quantifying the accuracy and timeliness of this forward-user data. On-going monthly performance statistics are being generated to gauge the performance of the MCS with reference to existing legacy strategic and theater processing centers, as well as with reference to best-estimate 'truth data'.

This presentation will focus on the comparison and improvements noted, specifically in strategic/space launch parameters compared against legacy monocular reporting sites. We will also present a comparison of SBIRS theater data against the baseline established by ALERT – the legacy theater processing element upon which the SBIRS Increment 1 processing component was initially established.

Initiatives of the AFSPC Space Analysis Center

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Air Force Space Command (AFSPC) stood up its new Space Analysis Center (ASAC) on 31 Aug 2001. The ASAC is the Air Force center of excellence for space-oriented analysis, whose vision is "Shaping national space capabilities through analysis." The ASAC's mission is to conduct analysis across all AFSPC mission areas in support of requirements generation, planning & programming, acquisition, operations, and support by: (1) assessing military utility of space and missile systems, (2) improving operational space capabilities, (3) quantifying space effects in exercises and wargames, and (4) acting as a key analysis focal point for collaboration within the national security space community. The ASAC faces several challenges in providing analysis to support the AFSPC Integrated Planning Process, in constructing a robust M&S toolkit for analysis and ensuring space is properly represented in joint and AF models, in developing a long-range research investment plan, and in adapting its mission and operating concept to match the changes in DoD as a result of the Air Force being designated Executive Agency for Space. This presentation will provide an update and status report on the purpose, progress, and initiatives of the ASAC; seek interaction with others in the space MS&A community; and build coordinated support for advancement of the space MS&A community's joint goals.

An Agent-Based Modeling Approach to Measuring the Value of a Proposed Information System

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For several years the U.S. Army and Department of Defense have struggled with how to measure the value of battlefield information. Digital information systems have demonstrated the potential to significantly increase the combat effectiveness of our forces, but in order to make procurement, force structure, and basis of issue decisions, we would like to gauge the extent to which these systems increase combat effectiveness. This paper describes a methodology we chose to investigate whether an agent-based-model (ABM) could be used to suggest appropriate behaviors for a combat force equipped with a proposed information system such as Future Battle Command Brigade and Below – FBCB2. The decision agents within the model will use the information about enemy forces, friendly forces, and terrain provided by the proposed information system to adjust the friendly course of action to the updated situation. Our methodology is a three-step process. We first execute simulation runs using an existing dynamic study scenario and evaluate the results of these runs. In the second step, we transfer the terrain, units, and course of action from the existing dynamic scenario to an ABM with intelligent agents that will refine the course of action genetic algorithm by generating new unit positions and routes based upon the current situation. In the final step, we substitute the ABM developed course of action and behaviors back into the dynamic study scenario and execute another set of simulation runs. The performance of the friendly force using the proposed information system and ABM generated behaviors may be compared to the performance of the friendly force which failed to take advantage of current information. This gives insight into the potential increase in combat effectiveness realized through the use of an information system.

Joint Global Positioning System Combat Effectiveness (JGPSCE) Joint Test and Evaluation (JT&E)

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On 29 July 1999, the Office of the Secretary of Defense (OSD), Deputy Director, Developmental Test and Evaluation (DD, DT&E), Strategic and Tactical Systems (S&TS), in cooperation with the Joint Chiefs of Staff and Services, chartered the JGPSCE JT&E. Over a four-year period, the JGPSCE Joint Test Force (JTF) is conducting a series of test events that focus on joint operations where the Global Positioning System (GPS) is denied or degraded by hostile electronic warfare (EW) or friendly electromagnetic interference (EMI). Specifically, the JGPSCE JT&E is addressing the following issues:

Issue 1: What is the impact of GPS vulnerabilities on the effectiveness of joint operational missions that require precision engagement?

Issue 2: What changes in joint tactics, techniques, and procedures (TTPs) or system-level mitigation techniques improve or maintain joint operational mission effectiveness in the event of GPS EW and EMI?

Issue 3: What test methodologies can be employed to characterize GPS vulnerabilities in future acquisition and integration programs?

The JGPSCE JTF conducted its second field-test—*GYPSY BRAVO*—from 11 Jan 02 through 25 Jan 02 at Fallon NAS, NV. *GYPSY BRAVO* test participants included Air Force F-16C Operational Test Crews, Air Force F-15E Operational Test Crews, Navy and Marine F/A-18 Operational Crews, and Army AH-64D Test Crew. Crews conducted interdiction missions in the context of a medium-scale contingency scenario. This presentation will focus on the *GYPSY BRAVO* test concept, test methodology, and test results.

Measuring the Difference in Force Effectiveness Resulting from Changes in Information Systems

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For several years the U.S. Army and Department of Defense have struggled with how to measure the value of battlefield information. Digital information systems have demonstrated the potential to significantly increase the combat effectiveness of our forces, but in order to make procurement, force structure, and basis of issue decisions, we would like to gauge how well proposed information systems perform.

This paper describes a methodology we chose to assess the value of an information system (Force XXI Battle Command, Brigade and Below – FBCB2) to the battlefield decision maker. Our approach focuses on use of the CASTFOREM combat model with emphasis on tying decisions and activities to available information. We discuss use of a detailed communications modeling/information flow capability in CASTFOREM, situational awareness databases at the platform level, decision-making logic, and the incorporation of enhanced Combat Service Support modeling driven by communications and self-determined movement routes.

Analytical Support to the Schriever 2002 Space Game

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The Schriever 2002 Space Game is one of the preeminent space wargames in the DoD. The Schriever 2002 wargame objectives are to examine both military and commercial space assets in a 2015 scenario to: 1) Explore impacts of alternative space laws, policies and strategies on future space operations, 2) examine space in emerging transformational concepts (Land, Sea, Air, Space and IO), and 3) Provide insights for effects based acquisition. A series of pre-game workshops will be held to examine issues pertinent to each of the individual objectives. This presentation will discuss the analytical support during the pre-game, game and post game phases of the Schriever 2002 wargame. The analytical methodology centers on the development of a series of research questions that link the game objectives to both the appropriate venue to address the research question (i.e. either a pre-game workshop, the actual wargame, or both) as well as the analytical toolset required to perform required analysis to answer the research question(s).

Initiatives of The Space Users Group

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Abstract unavailable at printing.

Quantifying Utility Based on GPS Performance Attribute Values

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The GPS Performance Attribute Analysis Tool (GPAAT) was developed to compute and analyze the military utility of various GPS performance attributes, such as availability, accuracy, integrity, and received signal power. This framework has been built to assist in the determination of GPSIII design specifications by calculating and analyzing the linkages between specific system Performance Attributes and operational Measures of Merit. GPAAT's construct is modeled around the complete "strategy-to-task" decomposition of Joint Vision 2020. GPS performance attribute values are used to calculate Measures of Performance (MOP), such as navigation error and CEP for use cases within the JV2020 decomposition. GPAAT provides traceability from MOPs to Measures of Utility (MOU), including Measures of Effectiveness (MOE) and Measures of Outcome (MOO). This tool determines performance-cost trades for military operations by analyzing the cause-effect relationship between performance attributes and cost. This analysis approach will enable military decision makers to quantify the benefits associated with improving specific performance attribute values. The presentation includes an outline of the tool structure and flow, a sample scenario of military use cases, and utility analysis.

Space Based Radar – the Warfighter's Perspective

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DoD Joint C4ISR Decision Support Center sponsored a Force-on-Force Analysis conducted by Space and Missile Defense Battle Labs (SMDBL) Studies and Analysis Division. Results contributed to the overall DSC study submission during the Milestone-A or DSAE review. The SMDBL Study was a constructive analysis utilizing Satellite Toolkit (STK), JANUS and System Effectiveness Analysis Simulation (SEAS) to determine the utility of Space Based Radar (SBR) to the Warfighter in the close and deep fight. The timeframe of the analytical fight was 2008-2010. EEAs included Blue force effectiveness with and without SBR, Blue force effectiveness with LEO versus MEO SBR architectures, and Blue force effectiveness sensitivity to SBR timeliness. The study used an approach that was architecturally neutral.

Arnold Engineering Development Center (AEDC) Space Presence Review Team (SPRT) – Developing a Space Test and Evaluation Strategic Plan

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Unprecedented events are now occurring in the DoD Test and Evaluation (T&E) world. Many of these events are spawned by the evolution of near-earth space as a theater of war. The DoD has a clearly stated goal of developing the technologies, doctrine, and systems to ensure US dominance of the Space Theater. In the near-term, the actions of the Rumsfeld space commission aimed toward this goal will have significant impact on space T&E operations at AFMC, and how AFMC supports AFSPC. In the far-term, space T&E will likely undergo an even more profound change. In order for the DoD to be prepared to test space systems required to meet the demands of US national security, steps to understand those requirements and assess capabilities against T&E needs must be taken.

Events happening within the last few months at the AFMC, AF, and OSD levels, including transfer of the Space Single-Face-to-Customer (SFTC) office from SMC/TE to Arnold Engineering Development Center (AEDC), reorganization of SMC to AFSPC, and the call for an umbrella space test organization from the OSD CTEIP office, emphasize the need for action at this time. The Space Presence Review Team (SPRT) is taking action to ensure space T&E needs are met.

Acting under the SFTC responsibility, the Arnold Engineering Development Center (AEDC) is undertaking a strategic planning effort to assess future requirements for the Department of Defense (DoD) space test capabilities. AEDC has organized the SPRT, which is a team comprised of representatives from across the DoD space community. The SPRT will identify shortfalls and recommendations and develop a process to compare space test investment options. This process will allow appropriate organizations to develop solutions to meet the highest priority need.

This presentation will discuss the SPRT process and analysis framework approach to develop a space T&E strategic plan that includes:

a. Develop an analysis hierarchy for the space T&E value model. This will include gathering of data to validate the hierarchy.
b. Define quantitative aspects of the model. This includes defining performance measures and "value" functions, and validating the performance measures and value functions.
c. Application of the value model to identify space test limitations. This includes comparing T&E needs against national capabilities. This also includes developing recommendations for appropriate DoD organizations to address shortfalls in T&E space test capabilities.

Developing a Space Analysis ToolKit

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The newly formed AFSPC Space Analysis Center (ASAC) is developing a process to create a Space Analysis ToolKit (SATK). In standing up, the ASAC is taking a zero-based approach to building the right set of modeling and simulation (M&S) tools and their supporting data with which to conduct analyses across all AFSPC mission areas in support of requirements generation, planning & programming, acquisition, operations, and support. Key to selecting the right models for inclusion in such a kit is selection of appropriate criteria for deciding to admit candidates to the toolkit. The ASAC's criteria set is based on a combination of UJTL-linked tasks and customer-driven analytic questions. The ASAC is applying lessons learned from the Air Force's construction of its Standard Analysis Toolkit, and previous ASAC experience in constructing a suite of tools used for the Ground Moving Target Indicator (GMTI) Analysis of Alternatives.

While there are literally hundreds of different space-oriented models available within the space community which could address these analytical M&S requirements, the ASAC could not feasibly use or afford the costs of development; verification, validation, and accreditation (VV&A); configuration management; and training for anything more than a small subset of these models and associated data files. The ASAC SATK will establish a minimal but sufficient set of off-the-shelf M&S tools satisfying the bulk of the ASAC's analytical requirements. The tools that will compose this SATK must undergo an accepted VV&A process.

Information Modeling of Future Technology; Using Complex Adaptive Systems to Model Warfare in the 21st Century

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We describe the modeling of warfare as a complex adaptive system with emphasis on the use of information in combat. Specifically, we address the ability of Agent Based Models to identify complex interactions that occur with the use of new technologies and how these models can be used in the analysis of potential future weapon systems. We explore the potential gains available in combat modeling from the inclusion of complexity in the modeling process under the guise of modeling the FCS in an agent based model.

Go-to-War-07 A Look at the Effects of Digitization on a Major Theater of War

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As the Army transforms in the 21st Century, we have relied on technology to achieve an edge in combat. Of specific interest is the Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) which is largely assisted by space based platforms (Global Positioning Systems (GPS) and information dissemination via satellites). This focuses technology as a tool for the commander to make better decisions because of better/more information. To this point, measurements have been mostly qualitative in nature (faster, better, more). What about quantitative measurements? This presentation seeks to answer this question as it relates to a major conflict at the theater level from the aspect of campaign duration, losses of major pieces of equipment, and casualties. Additional insights are also presented about the interactions between digital and analog forces as digitization is phased into the force.

Martial Arts Tenants: Balance, FOCUS and Power Applied to Air Force Space Command's Modernization Planning Tools

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The HQ AFSPC modernization planning methodology brings to bear two important areas of operations research, multi-attribute decision analysis (MODA) and binary integer programming (BIP). Value Focused Thinking is used to create a model to measure the military value of space systems. The scores from the value model become part of the input to a binary integer program that seeks to maximize military value subject to launch constraints, budget constraints, task coverage, the projected times for systems to become operational, and dependencies between systems. The BIP forces attention to the analytical details: mutual exclusivity and collectively exhaustive. The unexpected pay off is that by focusing on 77 measurable levels of the value model, we can map 200 space systems to the operational model of the day.

Huge strides in reducing cross command, redundant capabilities are being taken. We are now asked to describe system contributions across Air Force Missions and in terms that allow for comparison across commands. The overarching "models of the day" that we are asked to map to vary annually and are often defined in terms of operations or missions. These models lend themselves to understanding organizational requirements and perhaps to address quantity of required systems. There is some chance that they are even exhaustive in coverage of required capabilities, but experience has shown that they are not, by design, mutually exclusive. For the last four years, HQ AFSPC has used an analytical framework for modernization planning. The framework was originally built to perform space system trade-off analysis. It has proven to be not only useful in the business of modernization planning, but also in the tedious work of conforming to the latest new paradigm.

This presentation will describe then discuss how the balance and focus of the AFSPC value model saves resources. It will also illustrate the power of using BIP to discover potential solutions to buy the most capabilities in a cost constrained environment.

Chair: Jon Grossman, RAND
Co-chairs: Col William Adams, USA TRADOC Analysis Center
Keith Catanzano, Booz Allen & Hamilton Inc.
John Furman, MITRE
Michael Leite, SIM Inc.
Dennis Mensh, SIM Inc.
Advisors: Chris Chartier, Joint C4ISR Decision Support System
COL Patrick Vye, USA, Office of the Assistant Secretary of Acquisition Logistics & Technology
Bell Hall 20B
6A – Session 3 Bell Hall 21B; Session 4 – GIF 357B

The following abstracts are listed in alphabetical order by principal author.

Master Air Attack Plan (MAAP) Toolkit

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The Master Air Attack Planning Team develops the daily aerospace battle plan to accomplish aerospace tasks and achieve Joint Forces Air Component Commander objectives in fulfillment of the Joint Forces Commander mission. It must achieve maximum desired effects against the adversary. The MAAP process is time consuming and labor intensive. During planning, access to information such as weather, threats, and resource availability is not readily available nor is it presented in a manner that optimizes its near real time use. The Command and Control Battlelab's MAAP Toolkit brings real-time planning information to the MAAP Cell in an operationally friendly way that expedites MAAP development. Information feeds include unit level resource information, Modernized Integrated Database (MIDB), Air Operations Database (AODB), space planning information from the Space Battle Management System (SBMCS), predicted theater wide weather, other component plans (ground, air, maritime), the target nomination list (TNL), and Joint Task Force (JTF)/JFACC guidance. The MAAP Toolkit will electronically build mission/package worksheets and transfer this information to TAP via flat-file transfer without the need for human data entry. This automatic transfer of data will dramatically increase manpower effectiveness and reduce manpower requirements for both the MAAP Cell and Air Tasking Order (ATO) Production.

U.S. Japan Bilateral Study - Notional Sensor Platform

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USCINCPAC is involved in continuing analysis with allies in the Pacific region. Last year, USCINCPAC and the Japanese Joint Staff Office (JSO) initiated a new bilateral study. The study is a bilateral joint assessment of the benefits provided by a high altitude long endurance unmanned platform referred to as a Notional Sensor Platform (NSP) in conducting maritime surveillance of the Sea of Japan and its littorals to monitor ship traffic and support humanitarian assistance in natural disasters. This is the first analytic effort involving USCINCPAC and Defense Agency, Japan (JDA) since the Bilateral Sea Lines of Communications Study was completed in 1987. The procedures developed during this study will provide the basis for future bilateral analyses.

NSP provides a pseudo-satellite capability owned at the operational level. This provides a flexible sensor capability that can be tasked to respond to other requirements such as natural disasters. The Extended Air Defense Simulation (EADSIM) is the primary model for this analysis. Detailed command, control, and communication of the NSP were modeled in EADSIM to model the collection, processing and dissemination of imagery data. Two different command and control structures were modeled as well to measure the impact of Japanese Maritime Self Defense Force (JMSDF) C2 structure compared to a Joint C2 structure.

NSP may contribute greatly to collection of intelligence data for the Sea of Japan and its littorals. However, NSP's demands on the regional Intelligence, Surveillance, and Reconnaissance (ISR) infrastructure may be too high for practical use. This study will provide a preliminary assessment of NSP use, and may lead to more detailed analyses if relationships between NSP benefits and demands are favorable. USCINCPAC and JSO have coordinated a plan to develop the database, scenario, and objectives; execute model runs; and analyze output data.

This briefing will provide a brief description of the study objective, scope, approach, methodology, database and emerging results of this effort. This briefing describes two potential scenarios for the use of an NSP: maritime surveillance, and humanitarian assistance in a disaster. It concludes with estimates of NSP benefit/demand relationships.

Rapid Initialization of Course of Action (COA) Tools Using Data from GCCS

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Over the past several years, simulations have been increasingly used as a way of developing and evaluating courses of action (COAs) during staff-level training exercises. However, one of the major drawbacks in using such tools in the inability to rapidly populate such simulations with data that exists in C4ISR systems. In the majority of instances, unit data is read directly off of the available C4ISR system and input manually into the COA simulation. This process can be time consuming and is prone to errors - due to both the manual nature of the process and the fact that the tactical picture may change significantly by the time all the data has been input.

During the Navy's Global '01 Wargame last year, an automated process for initializing the Naval Simulation System (NSS) based directly on available track data in the Global Command and Control System (GCCS) was used for the first time in an exercise. The interface leverages standard M&S and C4I architectures - employing components based on the DII COE and the High Level Architecture (HLA). Use of this capability led to a significant improvement in the speed in which NSS could be initialized, and also the accuracy of the COAs evaluated. Because it was used directly by the NAVFOR cell in the exercise, it helped to streamline the C2 decision process for the training audience. The success of this application has led the Navy to employ it on the USS Coronado during the upcoming Fleet Battle Experiment - Juliet (FBE-J), during the summer of 2002.

This year the GCCS-NSS interface was extended to include a second COA application - the Integrated Theater Engagement Model (ITEM). The GCCS-ITEM initialization capability will be used during exercise Reception, Staging, and Onward Integration (RSOI) in Korea in the spring of 2002, and again during exercise Ulchi Focus Lens (UFL) in Korea later in 2002.

This presentation will cover lessons learned in all of the exercise and experimental uses outlined above and discuss future plans for both applications. It will also discuss potential future areas involving the interoperability of C4ISR and M&S systems that could significantly improve the C2 decision process.

Development of the C4ISR Logical Architecture for Network-Centric Units

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This presentation will focus on issues surrounding the logical development of the Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) network in a network-centric unit. The central medium for this presentation will be a summary of an actual development process conducted for a notional Future Combat System (FCS) based brigade force design. This work, the brigade force design, and its corresponding C4ISR structure, is taken from the Objective Force Survivability Study, a U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC) directed study. The summary will define relevant terms, establish a common understanding of the development method, outline the steps taken to develop a logical structure, and walk through examples of the logical flow of information.

Some Thoughts Leading Toward an Analytical Formulation for Network Centric Warfare

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Approved abstract unavailable at printing.

How Much is Enough Assessment of Data Requirements of U.S. Army Units from Combat Training Centers (CTCs) Data and Observations

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Over the last two decades RAND researchers have collected space data on specific aspects of units training at the CTC. In 1987 Dr. Martin Goldsmith demonstrated that both blue force and opposing force battlefield success at the National Training Center, (NTC,) was dependent on the accuracy of the unit's intelligence preparation of the battlefield. In the 1988-1990 time period Drs. James Kahan and Robert Worley investigated commanders' information requirements during the warfighter exercise at the Battle Command Training Program, (BCTP.) During this time, Goldsmith and Steve Kirin investigated data flow at the tactical artillery level at all three tactical combat training centers. In 1994, Dr. Jon Grossman determined the impact of GPS data on units' performance at the NTC, and developed a baseline database on battalion level command and control measures of performance. (MOPs) In 1995 Dr. Bryan Hallmark conducted similar research at the company level.

These research efforts indicated that the Army's digitzation effort could significantly enhance a unit's performance on the battlefield. The research, however, also indicated that many units were at their limits in their ability to process battlefield data and that digitization could potentially overwhelm a unit with more data than it could handle. During the Army's Advance Warfighting Experiments, (AWEs,) published reports indicated that both effects were observed. The same blue force unit was able to decisively use the digital data available to win one battle but, in the next battle, be overwhelmed by the massive amounts of digital data and lose.

Using the results of the RAND research and Army reports on the AWEs, an assessment of how much data is enough for units to "win" at NTC will be presented. Data, by itself, does not guarantee victory. How a unit processes data and uses the resultant information was found to be as important as obtaining the data. Observations on how high performing units at the NTC and BCTP appear to process data and use information efforts are presented. The presentation will conclude with a discussion of implications regarding the Army's digitization efforts.

Global Command & Control System T&E

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The Joint Interoperability Test Command (JITC) is forging new ground as the Operational Test Agency (OTA) for the Global Command and Control System (GCCS). GCCS is an automated information system designed to support situational awareness and deliberate and crisis planning with the use of an integrated set of analytic tools and flexible data transfer capabilities. GCCS will be the single Command, Control, Communications, Computers and Intelligence system to support the Warfighter from the foxhole to the command post.

The size and complexity of GCCS, coupled with the unique acquisition strategy and the dynamic schedule, pose challenges for the test community. JITC has developed a comprehensive strategy for GCCS Functional Qualification Testing (FQT) and Operational Test and Evaluation (OT&E). This strategy is designed to meet the unique challenges posed by GCCS and provide timely information to the Warfighter, Department of Defense (DoD) Joint Staff, Director Operational Test and Evaluation (DOT&E), Defense Information Systems Agency (DISA) and the Milestone Decision Authority (MDA).

As the operational tester for GCCS, JITC ensures the Warfighter's perspective is captured as value-added to the development process. During each Field Test JITC assesses the operational effectiveness and operational suitability of the GCCS version release under test.

Through interoperability certification, we ensure the Warfighter can obtain information that is accurate, timely, and useful. Based on the Warfighter's requirements for information exchange and through our efforts in evaluating incremental software releases, we help assimilate new and affordable technology more quickly into our fight and win systems.

Command and Control Battlelab Surveillance Management and Reconnaissance Tasking System (CSMARTS)

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Currently, no single intelligence, surveillance, reconnaissance (ISR) architecture/system exists in the Air Operations Center (AOC) to directly support management of ISR platforms and sensors. Specifically, the ISR and time critical targeting (TCT) operators work with disparate stovepipe systems that display intelligence information from a variety of sensors and message traffic. Hence, today's combat operations systems and infrastructure provide inadequate support for efficient re-tasking of ISR platforms. The Command and Control Battlelab (C2B) developed and proved an ISR Battle Management (BM) concept of operations (CONOPS) and tactics, techniques, and procedures (TTP) which codified ISR processes and procedures within the AOC. This effort utilized two existing tools: the Joint Services Workstation (JSWS) and the Integrated Collection Situational Awareness System (ICSAS). JSWS is used for battlespace visualization, while ICSAS is used for sensor/platform situational awareness. The C2B's CSMARTS initiative will take these processes and create an operating environment and a common viewing environment that includes the JSWS and ICSAS, in addition to the Web-enabled Temporal Analysis System (WebTAS). CSMARTS will significantly enhance ISR and TCT personnel's ability to identify, exploit, and target potential threats. This in turn reduces execution time and improves the kill chain through better situational awareness.

Divisional versus Functional Organizations: Contrasts for Different Tasks

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For the past several years, the ONR-sponsored Adaptive Architectures for Command and Control (A2C2) research team has examined the concept of organizational "congruence." This is a contingency theory paradigm that proposes that organizational effectiveness can be improved when characteristics like organizational structure are designed to fit the requirements of the mission or environment (e.g., Donaldson, 2001; Van de Ven & Drazin, 1985). Similarly, when the structure is out of "alignment," quality of performance should be reduced and, if significant, this misalignment may drive organizational adaptation. Some previous A2C2 efforts have examined ways to measure "fit" or "alignment" between structure and task requirements (e.g., Levchuk, Meirina, Levchuk, Pattipati, & Kleinman, 2001). The research to be reported here focuses on an experimental effort to determine factors that make tasks well suited for one organizational structure and poorly suited for another. The paper presents the most recent research findings and plans for future experimentation that further the investigation of organizational congruence.

In order to test the congruence theories empirically, our approach is to seek two sufficiently disparate organizational structures and design two missions (or scenarios) that would exploit the differences in these two structures. Thus, the first scenario would be "tuned" to organization 1 through a high degree of congruence, and would also be "mismatched" (i.e., exhibit low congruence) with organization 2. Clearly, the reverse is necessary for the second scenario. Before directly embarking on such an experiment we decided that it would be necessary to first conduct a Concept Experiment to elucidate the characteristics/properties of the mission (tasks) needed to meet our scenario design requirements for the yet-to-be selected organizations. In short, given the web of variables that influence performance, the nature of the contextual factors that might affect congruence is not obvious. Accordingly, the focus of this paper will be on the design and results from a Concept Experiment in which we examined the types of contextual factors that might be well suited for or challenge different organizational structures. Our goal is to further our understanding of specific task factors that can be used to determine the org form that will yield best performance.

A previous experiment (Hutchins, Kleinman, Hocevar, Kemple & Porter, 2001), co-sponsored by OPNAV-N6C and ONR and conducted at the Naval Postgraduate School (NPS) in March 2001, provided some important initial operationalizations of

organizations, mission and tasks for the Concept Experiment. In the N6C experiment, we examined the processes of self-synchronization among a set of geographically dispersed (Naval) commanders. A primary independent variable in that study was the definition of role responsibility (C2) that each commander had: a) Functional – in charge of a major warfare area theater-wide, or b) Divisional – in charge of a single, multi-function-capable platform. The mission environment was significantly characterized by a variety of time-critical tasks (e.g., SCUD missile launchers, Search and Rescue).

The two organizational structures examined in the N6C research were viewed as suitable candidates for the Concept Experiment, and many of the tasks that constituted the overall mission were sufficiently complex to provide a situational context to examine differences in processes and performance for the different structures. However, one major change from the N6C experiment was necessary: In the previous experiment a functional warfare area commander did not necessarily "own" all of the assets that had major capability in his/her assigned area. (This was a research design constraint to give the same asset ownership pattern for both functional and divisional organizations.) To achieve truly Divisional and Functional organizational structures, it was necessary to give commanders direct (rather than indirect) control over assets in both structural types. This change was instituted in the Concept Experiment.

Thus, the Concept Experiment that we conducted (and is reported in this paper) examined both a functional and divisional organizational structure performing a single mission that consisted of a variety of complex tasks. The mission tasks were virtually unchanged from the N6C experiment, but as noted asset ownership (who owns what) differed for the two structures. The experiment was conducted at NPS in October 2001 using the same DDD (Distributed Dynamic Decision-making) simulator as the N6C experiment. A total of 42 student/officer players were assigned to seven six-person teams. Each team played in both functional and divisional conditions, with order counterbalanced across teams. There were two primary purposes of this study: 1) to pilot test the operationalization of the two organizational structures in DDD, and 2) to gather data on performance and processes on different task categories to identify the types of contextual factors that determine organizational congruence and ultimately influence organizational performance.

The data that were collected included: a) DDD/computer recordings of all decision-maker actions (includes who attacked what and when, who launched which asset and when, etc.); b) voice-recorded communications data; c) decision-makers' self-reported data on performance, teamwork, workload, etc. as well as comparisons of the two structural types on key characteristics (e.g., flexibility, situational awareness, coordination); d) SME/observer data on performance of key time-critical tasks (SCUD launchers), decision-makers' teamwork and performance; e) after-action reviews by the participants. As one of the major goals of this experiment was to determine the characteristics of those tasks that would be performed well by structural type, but not the other structural type – and vice-versa – our analysis examined differences by task class. Typical task classes included: SCUD missile launchers, hostile aircraft, hostile patrol boats, coastal defense missile launchers, search-and-rescue, etc. In all there were some 25 different task classes (each with a number of instantiations) that constituted the overall mission.

We analyzed performance using a number of measures for selected task classes. Preliminary data suggest that performance indeed depended on task class. For instance, performance in the functional architecture tended to be superior for tasks such as SCUD missile launchers and the attack of an air base, whereas performance in the divisional architecture tended to be superior for tasks such as interception of SCUD missiles and torpedoes launched from hostile submarines.

Discussion in the paper will focus on the processes that lead to performance differences on various task classes, and how these differences might be constrained by contextual effects related to specifics of the scenario and structures explored in this investigation. Ultimately, these data will be used to define task characteristics for which certain structural types are better suited. These characteristics will result in recommendations that will outline the design of the two scenarios that will allow us to test the congruence hypothesis in the next experiment to be conducted in May 2001. These scenarios will be designed so that, in one scenario one structural type should evidence "fit" through high performance, while the other structural type should evidence "misfit" or lack of congruence. In the second scenario, a reversal of alignments should be evident. From these data, we will gain greater insight into how misalignment could drive organizational adaptation. In order to further our work on adaptive organizations, one goal in this series of experiments is to identify key cues or signals that indicate when misalignment is substantial enough to motivate organizational adaptation, the teams' approaches to that adaptation, and how the cues and approaches vary depending on the initial structure.

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Collaboration and Knowledge Management in an Experimental Effects-Based Operations Environment

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Effects-based Operations (EBO) is defined as a "process for obtaining a desired strategic outcome, or 'effect' on the enemy, through the synergistic and cumulative application of the full range of military and nonmilitary capabilities at all levels of conflict." [p. ii, 1] An effect is the physical, functional, or psychological outcome, event, or consequence that results from specific military or non-military actions. The EBO concept is based on the tenant that a better understanding of the adversary and the increased involvement of other national agencies will lead to better-reasoned options to engage potential adversaries.

Key aspects of EBO are the ability of decision makers to quickly recognize any unexpected effects and the flexibility and agility to adapt to the implications of those effects. This highly adaptive quality is anticipated to increase prospects for success while reducing the potential for failure. A second key aspect of EBO is an emphasis on the ability to examine the causal linkages and effects through which actions lead to objectives. Causal linkages help planners understand why a proposed action could be expected to produce a desired effect given the current circumstances. A third aspect is the broadened focus of the Joint Task Force (JTF) Commander to producing effects against an adversary's will and behavior in addition to his means and capabilities. This ability to more precisely select the right set of actions offers the Joint Force Commander the ability to further minimize undesired collateral effects.

An experiment entitled Effects Tasking Order-to-Actions Limited Objective Experiment (ETO-to-Actions LOE), was conducted at the US Joint Forces Command (JFCOM), Joint Experimentation Center, Suffolk, VA, 3-14 December, 2001, to examine aspects of EBO, and to specifically assess and refine the effects-based planning and assessment (EBPA) processes. This experiment was designed and conducted by a partnership of the Naval Postgraduate School, JFCOM J9, and the Navy Warfare Development Command. Previous experiments and events focused primarily on the Joint Force Headquarters (JFHQ) level of command, with the majority of effort directed at refining the process down to producing an ETO (which effectively issues effects-based orders to the subordinate functional components). The ETO-to-Actions LOE focused within and below the JFHQ to examine the required coordination and collaboration processes (both vertically and horizontally) between the JF and functional components headquarters, which is needed to collaboratively develop the ETO and translate the effects directed in it into tactical actions on the battlefield.

The experimental participants included representatives from all services, organized into a Joint Task Force HQ staff and functional component HQ staffs (air, maritime, land, special operations force, and political). Thirty-nine percent were active duty and forty-two percent were retired military personnel. Three days of training on the new processes and collaboration tools were provided to familiarize participants with the new concepts. Five days of game execution consisted of the collaborative planning between the Joint Task Force staff and the subordinate functional component staffs, culminating in the JTFC issuing an ETO to the Joint Force.

Three surveys were administered during the experiment to gather data on the effectiveness of (1) the collaborative tools and the training provided to the participants for this experiment, (2) knowledge management and collaboration as critical aspects of EBO planning, and (3) the EBO planning and assessment process. This paper reports on the results of the Knowledge Management and Collaboration Survey, and is a companion paper to two other papers that report on results of the other two surveys. Twenty-nine items comprised the KM survey. Participants were asked to rate the extent to which they agreed with statements by using a five-point Lickert scale that ranged from "strongly disagree" to "strongly agree." The survey was administered to the 99 experimental participants; 95 completed surveys were returned.

Survey items related to situation assessment and information management asked participants about their level of situation awareness within their cell and across the JTF/Component organization, their ability to obtain adequate and

timely information, types of information they were unable to obtain and causes of problems in obtaining information. Other survey items pertained to the effectiveness of the organization the effectiveness of asynchronous collaboration sessions; and the extent to which they were able to conduct collaborative planning that was closely coordinated with subordinate commands. In addition, survey items measured the effectiveness of the ONA, ability to assess the value of engaging a specific adversary node, and the presentation aspects of information.

1. *A Concept Framework for Effects-Based Operations*, White Paper Version 1.0, 18 October 2001. US Joint Force Command, J9, Concepts Department, Suffolk, VA.
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Model and Post-Processing Integration and Evolution for FCS Analysis

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The Army transformation to a full spectrum force will replace both the light and heavy forces of today and be fully capable to deal with all potential operations from small-scale contingencies to major theaters of war. The key material component of this objective force is the future combat system (FCS).

The emergent evolutionary network centric warfare concept and undefined FCS-equipped objective force required the Combined Arms and Support Task Force Evaluation Model (CASTFOREM) to enhance the representation of information and situational awareness. The modelers and analysts expanded modeling and simulation (M&S) capabilities for gathering, processing, dissemination, and effects of technical design, organizational, and tactical engagement information.

This paper will describe the CASTFOREM model growth that has taken place in order to represent "a system of systems" concept and will detail evident shortcomings and potential short and long term modeling solutions. To handle the volume of data and number of scenarios, the TRADOC Analysis Center - WSMR created a capability to quickly analyze model output, at any resolution of interest, from individual entity examination up to force level scrutiny. The resulting software is a suite of post-processing tools formally called TRADOC Analysis Center Helpful Engagement Acquisition Toolbox (TRAC HEAT), Unit Profiles (TRAC Pro), and network and communication analysis (TRAC Net). Modelers have developed a post-processed output formats that TRAC suite can use.

Integrated Communications Replication in CASTFOREM

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Objective Force and FCS are expected to rely heavily on integrated, seamless communications and situational awareness. Potential operating environments, including urban and other complex terrain, and geographical separation of entities within an operations area, both of which may affect communications, are factors to consider during the design of equipment, organizations, and doctrine.

High-resolution combat models do not typically play explicit communications at the entity level. Engineering-level models that could model communications do not typically replicate the interactions during combat operations, including attrition, battle damage, and logistics. CASTFOREM currently has a fairly robust communications architecture portrayal, but it falls short in its ability to model the system of systems communications constructs of the proposed Objective Force.

This presentation discusses ongoing studies in further advancing the simulation capabilities of CASTFOREM, developing new descriptive algorithms for embedding communications within a high-resolution combat model, and detailing the shortcomings that even a perfect replication might possess. The presentation will also highlight some vignettes used to test the application as well as emerging results.

Effects-Based Planning and Assessment: Examining and Refining the Process

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The United States Joint Forces Command (USJFCOM) J9 is leading a transition toward a new approach to warfare. A cornerstone of this new approach is the concept of Rapid Decisive Operations (RDO), which integrate knowledge, command and control, and Effects-based Operations (EBO) to achieve the desired strategic outcome or "effect" on the enemy through the synergistic and cumulative application of the full range of military and nonmilitary capabilities at all levels of conflict.[1] In preparing for and conducting a RDO, the military acts in concert with and leverages the other instruments of national power to understand and reduce the adversary's critical capabilities and coherence. Focusing on effects, rather than attrition, enables a highly coordinated level of interservice, interagency, and international cooperation.

The shift to EBO effects both planning and assessment. Traditionally, military planners would focus on consideration of factors such as the number and type of aircraft to be employed, types and quantity of weapons to be used, and the number of sorties to be flown. Now the goal is to emphasize what all these weapons and platforms will accomplish, that is, what overall *outcomes* will be achieved.[3] Similarly, the effects assessment (EA) process goes beyond traditional attrition-related and performance-related assessments included in today's combat assessment process. EA must be a continuous feedback process that can collect, process, exploit, and disseminate information to the appropriate level (strategic, operational, or tactical) in time spans that allow commanders to make decisions in an intensely dynamic situation. The EA perspective includes "determination of whether some, or all of, the desired effects were produced and, if so, to what level, what unintended effects were produced, their overall impact on the joint effort, and how the tactical actions taken either contributed or failed to contribute to obtaining the desired outcome." [3] The experiment reported on in this paper is part of a sequence of experiments and events planned to test and refine new concepts being developed at USJFCOM J9.

An experiment entitled Effects Tasking Order-to-Actions Limited Objective Experiment (ETO-to-Actions LOE), was conducted at the USJFCOM, Joint Experimentation Center, Suffolk, VA, 3-14 December, 2001, to examine aspects of EBO, and to specifically assess and refine the effects-based planning and assessment (EBPA) processes. This experiment was designed and conducted by a partnership of the Naval Postgraduate School, JFCOM J9, and the Navy Warfare Development Command. The previous experiments and events focused primarily on the Joint Force Headquarters (JFHQ) level of command, with the majority of effort directed at refining the process down to producing an ETO (which effectively issues effects-based orders to the subordinate functional components). The ETO-to-Actions LOE focused within and below the JFHQ to examine the required coordination and collaboration processes (both vertically and horizontally) between the JF and functional components HQs, which is needed to collaboratively develop the ETO and translate the effects directed in it into tactical actions on the battlefield.

This paper will focus on summarizing data obtained from a survey administered at the conclusion of this experiment to obtain feedback on how well the EBPA process worked. Survey items asked respondents to rate their answers, using a 5-point Lickert-type scale that ranged from "strongly disagree" to "strongly agree," on questions that asked about such topics as the following: areas of the effects-based planning and assessment process needing further refinement, what parts of the process are particularly challenging (so that these can be enhanced and more fully trained), what data/ information/assessments need to be provided to better enable the process, how well this process facilitates development of more complete/ robust courses of action, and whether JTF planners were able to develop measures of effectiveness for the desired effects that were meaningful and observable. Additional areas included in the survey include items regarding whether use of the Prioritized Effects List supports JTF-level decision making, whether the right number of people were involved in the planning process, the ease with which participants were able to stay informed when updates and changes were made, the effectiveness of the components participation in the planning process, and several other aspects of the effects-based planning and assessment process.

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An Agent-Based Modeling Approach to Measuring the Value of a Proposed Information System

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For several years the U.S. Army and Department of Defense have struggled with how to measure the value of battlefield information. Digital information systems have demonstrated the potential to significantly increase the combat effectiveness of our forces, but in order to make procurement, force structure, and basis of issue decisions, we would like to gauge the extent to which these systems increase combat effectiveness. This paper describes a methodology we chose to investigate whether an agent-based-model (ABM) could be used to suggest appropriate behaviors for a combat force equipped with a proposed information system such as Future Battle Command Brigade and Below – FBCB2. The decision agents within the model will use the information about enemy forces, friendly forces, and terrain provided by the proposed information system to adjust the friendly course of action to the updated situation. Our methodology is a three-step process. We first execute simulation runs using an existing dynamic study scenario and evaluate the results of these runs. In the second step, we transfer the terrain, units, and course of action from the existing dynamic scenario to an ABM with intelligent agents that will refine the course of action genetic algorithm by generating new unit positions and routes based upon the current situation. In the final step, we substitute the ABM developed course of action and behaviors back into the dynamic study scenario and execute another set of simulation runs. The performance of the friendly force using the proposed information system and ABM generated behaviors may be compared to the performance of the friendly force which failed to take advantage of current information. This gives insight into the potential increase in combat effectiveness realized through the use of an information system.

Measuring the Difference in Force Effectiveness Resulting From Changes in Information Systems

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For several years the U.S. Army and Department of Defense have struggled with how to measure the value of battlefield information. Digital information systems have demonstrated the potential to significantly increase the combat effectiveness of our forces, but in order to make procurement, force structure, and basis of issue decisions, we would like to gauge how well proposed information systems perform.

This paper describes a methodology we chose to assess the value of an information system (Force XXI Battle Command, Brigade and Below – FBCB2) to the battlefield decision maker. Our approach focuses on use of the CASTFOREM combat model with emphasis on tying decisions and activities to available information. We discuss use of a detailed communications modeling/information flow capability in CASTFOREM, situational awareness databases at the platform level, decision-making logic, and the incorporation of enhanced Combat Service Support modeling driven by communications and self-determined movement routes.

OODA Versus ODOA

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Most military planners and commanders are familiar with OODA (Observe-Orient-Decide-Act) loops. The OODA loop was the brainchild of the late COL John R. Boyd (USAF Ret), who developed this approach to warfighting based upon his experiences during aerial combat in the Korean War. His loop has been applied to all levels of warfare and is based upon

operating inside of the opponent's decision cycle.[1] This OODA loop construct has stood the long test of time, but needs to be updated for the Information Age. Currently, our decision cycle is mired in the past. Only marginal changes are occurring as we apply technology to the existing military decision process.[2] We have to transform this process to fully leverage the technology of today and the future. It needs to be adjusted to ODOA (Orient-Decide- Observe-Act). With today's Revolution in Military Affairs (RMA) or Evolution in Military Affairs (EMA)[3], one thing is certain – knowledge and speed drive our operations. Knowledge is the key to battle space dominance and speed is seen as the key to exploiting this knowledge. These two qualities are the keystones of planning for the future.[4] In the Information Age where exchanges occur at the speed of light, operations are more time sensitive than ever before. We have to use time to our advantage and drive the operational events. Our decision cycle must be such that it drives the tempo of military action and never allows the opponent the luxury of proactive interaction. The opponent is overwhelmed and is in a constant reactive mode. Initiative is ours. ODOA is a simple construct, which will change the way we do business and leverage the attributes of knowledge and speed in the Information Age. The purpose of this paper is to examine Boyd's OODA loop and the ODOA construct within the framework of the United States Joint Forces Command's (USJFCOM) Rapid Decisive Operations (RDO) concept. First we will explore Boyd's OODA loop and describe the emergent RDO concept being explored by the USJFCOM J9. Next we will examine the benefits of ODOA with respect to this emergent concept followed by its application to warfare at the speed of light. Although there may be applications at other levels of warfare, this paper will focus on the operational level.

Using Games and Adaptive Agents in C2 Research

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This in-progress briefing will 1) describe an approach to C2 research using adaptive agents and games, and 2) discuss results to date (which, as of June 2002, are anticipated to be available from the adaptive agent work but not from the subsequent human player games).

The project's sponsor is the Joint C4ISR Decision Support Center (DSC); they are developing a future Joint Task Force C2 operational concept and architecture.

Previous DSC work identified eleven key C2 design characteristics, including preparation and training; shared awareness; and agility. These eleven characteristics and their related MOPs form a large potential design space for C2 systems and processes. Determining how each characteristic affects C2 and the interplay (either negative or positive) among the characteristics is difficult.

In 2002, ThoughtLink (TLI) and the Center for Naval Analyses (CNA) are conducting two inter-related tasks. CNA will start by developing an adaptive agent simulation of some of the C2 characteristics. We will run the simulation many times, to intensively explore as much of the design space as possible.

Based on the interesting results from the agent-based simulation, TLI will create a game for human players and we will conduct an experiment delving more deeply into these parameters.

This work builds on research conducted in 2000 and 2001 for DARPA using an abstract, online, C2 game called SCUDHunt. TLI and CNA used SCUDHunt to conduct a statistically designed experiment and analyze its results. The original analysis, as well as a subsequent effort for the DSC, allowed us to explore the effects of various factors on the shared situational awareness and quality of decisions in distributed teams.

Joint Air Operations Center (JAOC) Information Viewing Environment (JIVE)

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[1] Gray, Colin, Modern Strategy, p. 91.

[2] Littlefield, Thomas K., Jr., "The Military Decision Process – Overlooked by the Revolution in Military Affairs", http://stinet.dtic.mil/cgi-bin/fulcrum_main.pl, Filename: ADA344635.pdf.

[3] Much has been written and expressed concerning whether we are in a revolution or evolution. I believe the semantics of this are moot. The bottom line is that we are in a period of change and with the great and continuing strides in the digital world. The change is moving a rapid rate with a definite acceleration. As military professionals we can never be comfortable with the status quo. As we move up the never-ending staircase of advancement in warfare, one foot must be reaching for the next step, hopefully ahead of the competition. If not we would suffer the same fate of the Stone Age societies that met the industrial age - Annihilation and a chapter in history.

[4] Adams, Thomas K., "Future Warfare and the Decline of Human Decisionmaking", Paramenters, VOL.XXXI, NO.4, Winter 2001-02, p. 59.

Currently, no single viewing environment for all data sources exists in the Air Operations Center (AOC.) The USAF Command and Control Battlelab's JIVE initiative had four goals: access disparate data sources simultaneously to geo-spatially and temporally visualize data on one common viewing environment, improve the Joint Forces Air Component Commander (JFACC) and his staff's situational awareness, rapidly provide decision quality information, and provide flexible viewing hardware options. JIVE utilizes and made enhancements to the Web-enabled Temporal Analysis System (WebTAS), developed by Intelligent Software Solutions (ISS), to meet its objectives. JIVE facilitated both access to both static and streaming data sources, enables the user to filter data objects and tracks and can project the resulting composite operational picture as overlays on a super-high resolution, large field of view datawall for improved AOC situational awareness. WebTAS can also analyze accessed data. The JIVE initiative reviewed several hardware options to include a 5 X 10ft datawall, appropriate for audiences of 8-12 people, a 50 inch flat plasma screen for audiences of 5-7 people, and a standard monitor or laptop. As a result of JIVE, AOC staff situational awareness and decision-making capability increased.

Command Post of the Future: Functional Requirements, System Modeling and Analysis.

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The past decade has seen a shift in the focus of our military operations from a major theater of war to many types of operations other than war including peace making, peacekeeping, and humanitarian support, counter-terrorism and cyber terrorism. Current headquarters elements that command and control such forces have, at best, only made marginal changes in organization, structure and equipment to adapt to new missions and technologies. This paper will discuss the applications of systems engineering and operations research to reengineering operational-level command and control systems around the flow of information to facilitate decision-making and enhance military force effectiveness. The focus of our paper will be on defining functional requirements, related architectures, and modeling and analysis of information flow and information operations within the headquarters.

Automated Logistics Information to the Air Operations Center (ALIA)

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Currently, no readily accessible, decision-quality, combat support (CS) information is available to the Director of Logistics (A4) to support the Commander, Air Force Forces (COMAFFOR) or the Joint Force Air Component Commander (JFACC) in the Air Operations Center (AOC). Combat support data is manually collected as required and all reports/information are manually generated. Gathering the data is labor intensive and time-consuming, and it results in an ineffective use of personnel.

The goal of the Automated Logistics Information to the AOC (ALIA) initiative was to provide the JFACC staff with current, accurate, decision-quality CS information. To accomplish this, ALIA captures and compiles wing-level CS data, available in Theater Battle Management Core Systems-Unit Level (TBMCS-UL), using Broadsword capabilities. Broadsword is an Air Force Research Lab program that provides users simultaneous access to multiple and geographically separated data sources through employment of a secure web browser. Broadsword automatically compiles the data retrieved from TBMCS-UL systems throughout the area of operation (AOR) into CS decision quality web-based reports and stoplight charts tailored to meet the needs of the AFFOR/A4 and AOC staff.

Weather Access for Visualization and Exploitation (WAVE)

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The Weather Access for Visualization and Exploitation (WAVE) initiative will provide a web-enabled interface for accessing XML encapsulated decision quality weather data for warfighter Command and Control (C2) and mission planning applications. These applications currently rely on human mental ingestion and exploitation of pictorial images of weather data. Interpreted data must be manually entered into the warfighter and C2 applications. The C2 Battlelab, in partnership with Air Force Research Lab, and with the support of the Electronic Systems Center, will develop an Application Program Interface (API) to the Joint Weather Impact System (JWIS). Utilizing state of the art XML tags, WAVE will enhance the Environmental Data Cube in JWIS, and build a business-to-business style API allowing warfighter and C2 applications to access decision quality, geo-referenced weather data. The capabilities of WAVE will be demonstrated within the USAF C2 Battlelab's Master Air Attack Planning Toolkit to access weather data during Joint Expeditionary Forces experiment 2002 and Millennium Challenge 2002.

Speech Interface for Data Exploitation and Retrieval

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The Speech Interface for Data Exploitation and Retrieval (SPIDER) initiative utilizes state-of- the-art speech recognition technology to include natural language understanding modeling techniques, to enhance the Web-enabled Temporal Analysis System (WebTAS) for use by Joint and Combined Air Operations Center (J/CAOC) personnel. Spider will provide a simple and intuitive voice interface for data access, retrieval, exploitation, and visualization with the USAF Command and Control Battlelab's (C2B) JAOC Information Viewing Environment (JIVE) Datawall and Mission Air Attack Plan (MAAP) Toolkit initiatives. SPIDER seeks to capitalize on lessons and benefits learned during the C2B's Joint Applications of Speech Technology (JAST) initiative, such as increased data retrieval rates, ease of use, speaker independence, reduced learning curves, and increased efficiency during Chem-Bio operations.

Future Combat Systems (FCS) Command and Control (C2)

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As described in the Training and Doctrine Command's (TRADOC's) draft 24 January 2001 "The Objective Force Maneuver Unit of Action" Operations and Organization Plan, the elements that describe combat power are changing. Today combat power is defined as a linear function: the sum of maneuver, firepower, and protection multiplied by leadership. In the Future Combat Systems (FCS) equipped force, combat power becomes an exponential equation where the factors of maneuver, firepower, protection, and leadership are raised by the power of information.

This paper will describe the joint Defense Advanced Research Project Agency (DARPA) and U.S. Army Communication-Electronics Command (CECOM) Research and Development Center (RDEC) FCS C2 program, as well as the overall experimentation plan and the FSC C2 federation.

Go-To-War-07 A Look at the effects of Digitization on a Major Theater of War

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As the Army transforms in the 21st Century, we have relied on technology to achieve an edge in combat. Of specific interest is the Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), which is largely assisted by space-based platforms (Global Positioning Systems (GPS) and information dissemination via satellites). This focuses technology as a tool for the commander to make better decisions because of better/more information. To this point, measurements have been mostly qualitative in nature (faster, better, more). What about quantitative measurements? This presentation seeks to answer this question as it relates to a major conflict at the theater level from the aspect of campaign duration, losses of major pieces of equipment, and casualties. Additional insights are also presented about the interactions between digital and analog forces as digitization is phased into the force.

Joint Communications Network Analysis Techniques

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Appropriate Joint communications network modeling is required to ensure that proposed communications networks under study are both realistic and credible. TRAC-FLVN has experience in performing military network analysis for alternative "what-if?" studies. These studies include wide area network (WAN) performance analysis, technology migration, and bandwidth sizing. TRAC has learned that it is essential to develop realistic, plausible and operationally accurate techniques and modeling to ensure credible representation of the alternatives. This presentation describes how TRAC has used data collection from SIPRNET, GCCS (COP), GCCS (I3), and TBMCS in a Joint environment, e.g. JTF headquarters (main and forward) and functional Joint commands to determine whether a network requires improvement. It shows how local area network (LAN) probes, log files, "sniffer" data, and wide area network (WAN) probe data is used in a Joint communications network study.

This presentation describes simplified techniques for Joint communications modeling which accurately represents military communications infrastructure for the given measures of performance (MOP) and measures of effectiveness (MOE). It shows how mission critical data communications traffic flow is correctly modeled. It includes simplified procedures to ensure analytical rigor and credibility.

It illustrates techniques for Joint network analysts to use to simplify their analysis efforts. This presentation focuses on TRAC's use of a stochastic communications model for the Joint community. It will assist military analysts in conducting simplified communications network studies. A classified Enduring Freedom case study from CENTCOM including playback may be approved for release and available at the time of presentation.

Millennium Challenge '02 Data Instrumentation Techniques

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Army Transformation Experiment '02 (ATEx02) is the Army Experimentation Campaign Plan (AECP) event supporting the US Joint Forces Command (USJFCOM) experiment Millennium Challenge 2002 (MC02). MC02 is a major field experiment integrating Service and Special Operations Forces capabilities, consisting of both live and simulated forces. MC02 is designed to demonstrate the US forces capabilities to conduct Rapid Decisive Operations (RDO) in the 2007 timeframe.

This presentation describes data instrumentation and collection requirements and analytical approach required for one specific ATEX02 issue. The issue surrounds augmentation, reorganization, and additional capabilities required for an Army corps headquarters (HQS) to serve as a Joint Task Force (JTF) HQS. A corps HQS must have a mission-capable organization with an organization and supporting staff prepared to assume the role of a JTF in a combined operational environment. JTF's typically require augmentation. For a conventional Corps staff, this is normally an uncomfortable adjustment. Traditionally, a Corps staff has relied upon another U.S. headquarters (Army) to resource, synchronize and provide guidance, direction and approval. The presentation describes novel techniques for data instrumentation and addresses data collection issues in ATEx02 surrounding experimentation, observation, and analysis. It addresses MC02 jointly collected data and results analysis that will be required for this important Army issue. It describes how Army analysts will leverage data collection from GCCS (COP), GCCS (I3), and TBMCS at all the main and forward sites, e.g. JTF headquarters (main and forward) and functional Joint commands. This effort will require LAN probes such as SPECTRUM™, log files, "sniffer" data, and wide area network (WAN) probes. The presentation also describes innovative techniques for obtaining data and "screen captures" from the Information Work Space™ (IWS) collaboration environment at each of these Joint sites and afloat required during MC02.

Joint Data Support C4ISR Data Development

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The JDS office provides data support and development to a wide variety of DoD models and studies. JDS C4ISR data support across the spectrum of JAMIP models has recently received emphasis by OSD(C3I); these models run the gamut from campaign-level analysis with highly aggregated C4ISR representation, to more detailed system-level performance modeling. JDS is responsible for the preparation of authoritative source data into data sets appropriate for use in these models. JDS must identify the right "mix" of detail and aggregation that does not compromise the utility of model output in determining C4ISR impact on combat decision making and combat outcome. Additionally, JDS is responsible for the construct & implementation of the underlying process & structure that will not only collect & store the necessary data, but also implement V&V, transformation, data refresh, and identification, development, and implementation of system performance metric algorithms. Topics covered are: JDS charter; C4ISR data requirements; data sourcing & population; data "ownership"; security; data storage, transformation, & provisioning; data standards; and interoperability.

Future Combat Systems (FCS) and the Joint Distributed Engineering Plant (JDEP) (A Potential Venue for FCS Joint Experimentation)

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The Army is accelerating the acquisition of FCS to meet the transformation goals of the Chief of Staff of the Army (CSA), and DoD. Concurrently, OSD and other joint agencies are implementing JDEP. JDEP will provide a distributed test-bed for Service developers, testers, and warfighters. The time is right for the Army to try to bring these two programs together to support joint warfighting concept exploration, and Army acquisition officials in achieving a FCS First Unit Equipped (FUE) in FY2008. JV2020 promulgates a network centric warfare environment that can potentially provide unprecedented levels of situational awareness to the lowest tactical echelons. FCS network centric concepts have to be demonstrated to support acquisition decisions. Due to the complexity of the problem, the Army should develop small "scoping" experiments to evaluate net-centric warfare. This presentation will explore three compelling reasons why the Army should incorporate a JDEP construct in the FCS Test and Evaluation Master Plan (TEMP). First, by employing JDEP the Army will show commitment to FCS interoperability, and a means to assess network centric warfare development in a joint context. Secondly, it will be a method to incrementally test Command, Control and Communications On The Move (C3OTM); thus, illuminating some of the sensor to shooter linkages, responsiveness, latency, and throughput issues that the developer will have to consider for FCS. Finally, JDEP could support a compressed acquisition timeline by integrating live, virtual, and constructive simulations for testing FCS C4ISR concepts. The presentation will conclude with a "way ahead" for future FCS C4ISR testing approaches.

C3 Test Driver Scenario Development

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The Command, Control, and Communications Test Driver program was initiated in response to a Deputy Undersecretary of the Army for Operations Research (DUSA-OR) tasking. The US Army Test and Evaluation Command (ATEC), the US Army Simulation, Training and Instrumentation Command (STRICOM), and the US Army Electronic Proving Ground (EPG) lead the C3 Test Driver Program. The Program involves key participants within the TRADOC Analysis Center (TRAC), the Central Technical Support Facility (CTSF), the US Army Operational Test Command (OTC), and the TRADOC Threat

Support Directorate (TSD). The objective is to support developmental, integration, and operational testing of Army Battle Command System (ABCS) components using standard models, standard mission/message threads, and standard scenarios.

The scenario development effort was tasked in Phase I of the C3 Test Driver Program (FY01) to produce an unclassified, brigade-level scenario to be used as the background for C3 Test Driver message generation and traffic. This scenario was located on the National Training Center and featured a Force XXI brigade against an opposing forces division. Key events were identified within a scripted time-ordered event-list to initiate various mission/message threads. C3 Test Driver uses this message traffic to stimulate real systems under test, evaluate their performance, and facilitate developmental and integration testing.

Classified corps-division and brigade-level scenarios are being developed for use in Phases II and III of this program. These scenarios, and vignettes identified within them, will use a dynamic simulation and a robust set of doctrinal mission/message threads to additionally support operational testing and training.

Getting at Enemy Intent: Connecting Perception to Command in Combat Modeling

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The Joint Warfare System (JWARS) model is the next generation campaign-level model for joint analysis, under development by the JWARS program office. The model is C4ISR-centric by design, and has required original research to develop suitable algorithms for representing correlation, association, and fusion at the aggregated level of representation appropriate for a campaign-level model.

Original research is underway to support how the model can represent the perception of enemy intent at the operational level. Previous research efforts (presented at previous MORRS) have discussed the development of correlation, association, and fusion models to process sensor reports of detected enemy units into the operational perception. In the past, most models have lacked an explicit operational perception; those that have modeled one are limited to some form of this unit oriented data structure.

An explicit perception is a key to the ability to model many combat processes. Until now, combat simulation models with an explicit perception have used this information primarily to support short-term decisions: targeting for strike and triggers for (pre)planned operational maneuver. Although this represents a significant capability, it does not permit proactive actions on the part of a commander – those actions made not just for immediate gain, but to block and exploit planned enemy actions and command own forces for long-term gain. To make these decisions, the commander must have some perception of enemy intent. Modeling intent is also important from the perspective of showing the value of C4ISR systems and processes that increase our ability to discern intent.

The paper that will be presented in this session will discuss the directions this research has gone toward meeting the modeling goal. Previous research has demonstrated methods of modeling the fusion of multiple intelligence sources to show where the enemy has been detected; just as important, methods have been developed to perceive where the enemy is absent. The combination of these perceptions, along with IPB, terrain analysis, enemy doctrine, and friendly operational concepts, gives us the basis to develop some inferences about the likelihood of enemy actions – and the command actions that can be derived from these inferences. This paper will discuss the progress to date.

The research supporting this concept will be submitted, when complete, to the government for approval for implementation in JWARS. However, the basic research may be usefully applied to all combat simulations that have an explicit representation of an operational perception.

OR and Intelligence WG-7

Chair: Dr. Mark A. Youngren, MITRE
Co-chairs: Les Grau, US Army Foreign Military Studies Office
GIF 351C

The following abstracts are listed in alphabetical order by principal author.

Addressing the Cost and Value of C4I Information in AoAs

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The nature of major Air Force systems acquisitions is substantially changing. The systems themselves are much more information dependent, and many of the Analyses of Alternatives (AoAs) for these acquisition systems must address a trade of money spent on information vs. money spent on warhead. This presentation will focus upon several significant steps the Air Force has taken to improve how it analyses the value of information in AoAs, some still-needed improvements, and some problem areas as we continue to adapt the AoA process for C4I Systems. The specific areas of discussion include how to cost C4I Support to a weapon system and how to measure the "value" of C4I in a pre-warfare environment.

Techniques for Intelligence Analysis of Networks

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Since September 11th, a great deal of effort has been expended on intelligence analysis of terrorist networks. In general, most of this analysis has been conducted with the standard tools of the intelligence analyst -- reports from intelligence operations are collected, analyzed and interpreted. This presentation discusses an additional set of tools, the techniques for network mapping developed by Social Network research. Particular attention is provided to a special class of social networks, "covert networks," the type found in secret societies, criminal organizations and underground groups. The presentation discusses how the mathematical techniques from Social Network research can be applied to the same data available to traditional analysts yet lay bare important structures that are not easily discerned by traditional methods. The presentation concludes with practical recommendations for competing against such networks.

Automatic Target Cueing (ATC) tool for Unmanned Aerial Vehicle (UAV) Synthetic Aperture Radar (SAR) products

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Abstract unavailable at printing.

Counter Deception and Sense-Making during Urban Operations

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The current world situation begs us to examine requirements unique to urban military operations, to include counter-terrorism and homeland defense. We must develop a better understanding of the many complex factors (e.g., military, civilian, political, social, and physical/environmental) that interact to influence military decisions. During urban operations, US Forces are susceptible to deception, particularly information deception. The quality of military sense-making and decision-making in urban environments depends, in part, upon accurate assessments of others' interests, intentions, and capabilities, as well as accurate assessments of the environment or context within which the action takes place. Forming accurate perceptions is a challenge even under favorable circumstances where clear and unambiguous communication between parties or extensive preparation and rehearsal for a particular turn of events can occur. In complex urban settings, we must be prepared for unfavorable circumstances which might include occasions when events are unfolding at a very fast pace, or when the background noise of contradictory opinions interferes with the accurate gauging of *the* intentions of others. Included within these unfavorable circumstances is a subset in which one or more participant's attempts to deceive the other. Clearly, one of these requirements is the ability to make sense of the intentions, capabilities, and tactics of adversaries, The United States and our allies must assume that our adversaries will play *to* our weaknesses, which may include our capability to detect, make sense of, and counter deception operations. The focus of this presentation *is* a framework for information and knowledge to facilitate sense-making and to counter a sophisticated capability for deception during military operations in urban environments. Research hypotheses are suggested to further our understanding of information and sense-making requirements in support of urban military operations.

The Take-Down of Kabul: An Effective Coup De Main

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Abstract unavailable at printing.

Command and Control Battlelab Surveillance Management and Reconnaissance Tasking System

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Currently, no single intelligence, surveillance, reconnaissance (ISR) architecture/system exists in the Air Operations Center (AOC) to directly support management of ISR platforms and sensors. Specifically, the ISR and time critical targeting (TCT) operations work with disparate stove-piped systems that display intelligence information from a variety of sensors and message traffic. Hence, today's combat operations systems and infrastructure provide inadequate support for efficient re-tasking of ISR platforms. The Command and Control Battlelab (C2B) developed and proved an ISR Battle Management (BM) concept of operations (CONOPS) and tactics, techniques, and procedures (TTP) which codified ISR processes and procedures within the AOC. This effort utilized two existing tools: The Joint Services Workstation (JSWS) and the Integrated Collection Situational Awareness System (ICSAS). JSWS is used for battlespace visualization, while ICSAS is used for sensor/platform situational awareness. The C2B's CSMARTS initiatives will take these processes ands create an operating environment and a common viewing environment that includes the JSWS and the ICSAS, in addition to the Web-enabled Temporal Analysis System (WebTAS). CSMARTS will significantly enhance ISR and TCT personnel's ability to identify, exploit, and target potential threats. This in turn reduces execution time and improves the kill chain through better situational awareness.

Failed Analysis, Untapped Proven Analytical Techniques; A New Terrorism Indications & Warning Methodology

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This thesis proposes, designs, evaluates, and builds a new terrorism Indications and Warning (I&W) methodology that connects a master database template with a partly-automatic analytical process and matrix-based threat pictures that are displayed as web pages. "The best known instances of intelligence failures . . . are rarely due to inadequate collection," but are more frequently due to poor analysis, and are most often due to policy makers ignoring intelligence. Policy makers, however, ignore intelligence when analysis is weak; thus the problem again points to analysis. Analysis experts have described the benefits of numerous structured analytical techniques and the dangers of common warning pitfalls. Despite these analytical insights, many intelligence analysts do not develop and utilize analytical methods that exploit these proven techniques, which can guard against these recurring pitfalls. The terrorism I&W methodology proposed here combines four structured analytical techniques with the intuitive technique in a twelve-step, partly automated process that guards against twenty-four of the thirty common warning pitfalls.

This thesis includes a disk containing a ready-to-use template of this methodology with its web page interface and some sample threat pictures produced from terrorism, threat reporting on Saudi Arabia, Kuwait, and Bahrain from August 2000 to August 2001. The template on this disk could be used to establish a Counter Terrorism Community I&W web site.

Military Systemology: Past, Present and Future in the Russian Military

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This paper will address the origins and development of military systemology [voyennaya sistemolopgiya] in the Soviet and Russian Armed Forces and its relationship to the Revolution in Military Affairs and the development of military art. According to GenMaj Ryabchuk, Military Systemology is a New Branch of Military Science, formed on the edges where "Philosophy, Military History, Military Art, the Theory of Strategy, Operational Art, Tactics, Troop Control, Operations Research, Systems Engineering, General Systems Theory, Cybernetics, and Information Science Meet." The paper will consider the post-Gulf War debate among military theorists and analysts on the utility of military systemology for force planning, force development, and military art. The paper will focus on the works of Captain 1st Rank Shevelev at the Academy of the Academy of the General Staff and General-Major Ryabchuk.

Coalition Interoperability Trials in Joint Warrior Interoperability Demonstration (JWID) 2002

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The JWID Program, administered by the Joint Staff (J-6), a rotating Host CINC (USPACOM) and DISA (CITI) was established in 1991 and has been the predominant experimental event in the R&D community, eventually being competed with Army's First Digitized Division (FDD); the AF's EFX; and now Millennium Challenge. JWID02 is in transition from a technology demonstration event with some C2 Interoperability Trials (C2IT) being done on the periphery, to C2IT being highlighted by key emerging infrastructure technologies surrounded by specific C2IT proposed trials/experiments targeted for Coalition and Combined operational environments. JWID began its C2IT Program in 1997 concentrating predominantly on C2 interoperability with GCCS trials with other Allied partners' C2 systems. In 2001, C2IT was expanded to include four principal technology interest areas: (1) continuation of GCCS-COP trials; (2) collaboration and the first use of the newly designated standard for Defense wide collaboration – the Defense Collaborative Tool Suite (DCTS); (3) directory and messaging services using the Defense Message System (DMS); and (4) Geospatial Information and Imagery Services (GIIS) – which includes a comprehensive program of emerging portal and web services technologies called CINC21, and a specific coalition initiative coordinated through NIMA named the Coalition Portal for Imagery and Geospatial Services (CPIGS). As a result of the success of this expanded C2IT program (mainly US centric, but with rapidly increasing Allied C2IT program investment), JWID is now transitioning to be completely C2IT focused. The transition brings JWID into a program centered on C4ISR Technologies Interoperability for Combined and Coalition environments.

Now, in JWID02, C2IT participation is solicited from all defense industry and government programs to complement a comprehensive range of CINC specified interest areas for Combined/Coalition C2IT technologies participation. Language Translation capabilities is a new interest area as well as US Joint systems interoperability in preparing for future Coalition involvement with US Services digital systems. Technologies will be described as to their maturity in implementation within JWID, emerging results and lessons learned, and implications for evolving the JWID C2IT program. Although a limited assessment occurs within the JWID execution, the opportunities for analysis and data collection are significant. Because of the scripted nature of the operational environment, technologies are introduced into an n operational environment to showcase the specific technologies and force the use by selected warfighters for the explicit purpose of gaining operation feedback/data. With added investment of analysis, these technologies could be designed in numerous ways to focus on

selected criteria and data, targeted for analysis. This environment extends to the most likely US Combined Operations partners as well as a Coalition environment. The synergism, provided by separately resourced Allied partners' own C2IT programs, offer a robust and expansive venue which has yet to be well exploited. Opportunities for research and analysis are available in an environment that will represent future Combined/Coalition operations. JWID make the operational environment more conducive to extracting high fidelity data representative of future operations in a Coalition and/or Combined environment.

Analyzing Complex Threats for Operations and Readiness (ACTOR)

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Indicators of CBRN Activity: Applying Pattern Recognition Techniques to Terrorist Groups

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Data collected on known terrorist organizations allows agencies to build a statistical database of characteristics for each group to include their level of interest in the acquisition of chemical, biological, radiological or nuclear (CBRN) weapons. These data may be expressed on a numeric scale and used to compute a metric that measures the degree of similarity between groups with respect to these characteristics. In this paper, we suggest a heuristic pattern recognition approach to classifying CBRN intent based on a training set of twenty-seven observations representing sixteen unique terrorist organizations. Our suggested approach uses a vector of variable weights and model parameters that minimize the resulting misclassification rate for the training set and which remain stable with respect to cross-validation of the data. An analysis of the variable weights provides indicators of potential changes in a terrorist group's position on CBRN acquisition.

Decision Support System for Coalition Operations

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Abstract unavailable at printing.

Global Threat Awareness

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Our project confronts the challenge of categorizing and simplifying the numerous threats in the world. We must predict the threats and potential mission types the US Army will face in the future in order to effectively design the Objective Force. This team has approached this problem with cluster analysis. We plan to use cluster analysis to group the threats in the world by similar mission types and environments. We have designed a matrix that evaluates threat countries, chosen by us, with 9 categories. This matrix evaluates the countries' possible mission type and situation it presents our military if we were to deploy there. Some of the categories we use are terrain, government, military, and culture. Each country receives a score based off our scales and runs through our program. The program will compare each country with all the others' scores and evaluate how close the comparison country is. This will allow us to group similar countries to better prepare what types and quantity of units will be needed to achieve each mission.

OR and Intelligence

Getting at Enemy Intent: Connecting Perception to Command in Combat Modeling

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The Joint Warfare System (JWARS) model is the next generation campaign-level model for joint analysis, under development by the JWARS program office. The model is C4ISR-centric by design, and has required original research to develop suitable algorithms for representing correlation, association, and fusion at the aggregated level of representation appropriate for a campaign-level model. Original research is underway to support how the model can represent the perception of enemy intent at the operational level. Previous research efforts (presented at previous MORRS) have discussed the development of correlation, association, and fusion models to process sensor reports of detected enemy units into the operational perception. In the past, most models have lacked an explicit operational perception; those that have modeled one are limited to some form of this unit oriented data structure.

An explicit perception is a key to the ability to model many combat processes. Until now, combat simulation models with an explicit perception have used this information primarily to support short-term decisions: targeting for strike and triggers for (pre)planned operational maneuver. Although this represents a significant capability, it does not permit proactive actions on the part of a commander – those actions made not just for immediate gain, but to block and exploit planned enemy actions and command own forces for long-term gain. To make these decisions, the commander must have some perception of enemy intent. Modeling intent is also important from the perspective of showing the value of C4ISR systems and processes that increase our ability to discern intent. The paper that will be presented in this session will discuss the directions this research has gone toward meeting the modeling goal. Previous research has demonstrated methods of modeling the fusion of multiple intelligence sources to show where the enemy has been detected; just as important, methods have been developed to perceive where the enemy is absent. The combination of these perceptions, along with IPB, terrain analysis, enemy doctrine, and friendly operational concepts, gives us the basis to develop some inferences about the likelihood of enemy actions – and the command actions that can be derived from these inferences. This paper will discuss the progress to date.

The research supporting this concept will be submitted, when complete, to the government for approval for implementation in JWARS. However, the basic research may be usefully applied to all combat simulations that have an explicit representation of an operational perception.

Information Operations/Information Warfare WG- 8

Chair: Dick Deckro, Air Force Institute of Technology
Co-chairs: Capt **Jonathan T. Hamill,** SMC/XRDM
Capt **James A. Leinart,** USSTRATCOM/J535
LT **Charles W. McCaffrey,** NIWA
Crisanna Shackelford, LIWA
Ms. **Linda Weber,** MITRE
Advisor: Ms. **Jean Kopala,** Anteon Corporation
Bell Hall 21A

The following abstracts are listed in alphabetical order by principal author.

Measures of IO Effects Using the Joint Staff Analysis Model

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The Joint Staff Analysis Model (JSAM) was developed for the US Army Battle Command Battle Lab to analyze command post performance. JSAM has been selected as the Army's J/AWE tool to support Millennium Challenge 02. One application of JSAM is to develop measures of the effects of information operations on Blue or Red organizations. Since the model already models the performance of an organization without IO, including IO effects will provide quantitative measures of IO on organizational performance. Measures include times to complete tasks, resource utilization over time, quality of information products, effects on coordination, and other measures already represented in JSAM. We present a proposed approach for incorporating a JSAM-based IO analysis as part of a limited objective experiment for Millennium Challenge 02.

Network Interdiction and Disruption Basics

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This presentation is a basic tutorial introducing and contrasting the problems of logistics network interdiction and information network disruption. It introduces and contrasts the measures of effectiveness for the two classes of problem. It explores the challenge of moving from algorithms for interdicting the planar networks common in surface transportation to the far more complex problems of disrupting or interdicting the non-planar networks ubiquitous in information and air transport networks. A dynamic-programming based generalized shortest route algorithm will be presented for optimally interdicting planar networks. Some simple algorithms for disrupting small non-planar networks will be described.

Decision Superiority: What It Is, Why It Is Important, and How We Can Do It Better

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Last year the Institute for Defense Analyses sponsored a Workshop on Decision Superiority. Fundamental to the precepts of *Joint Vision 2020,* Decision Superiority is defined as "better decisions arrived at and implemented faster than an opponent can react…at a tempo that allows the force to shape the situation or react to changes to accomplish its mission." The purpose of the Workshop was to gain an improved understanding of the enabling elements of Decision Superiority and to describe how to organize, deliver, and use information to achieve this capability. The Workshop provided an opportunity for experts in training, information technologies, command and control organizations and doctrine, and behavioral science, as well as senior military personnel, to focus critical thinking on this important topic. Ultimately, we plan to define metrics that describe our ability to achieve Decision Superiority. This briefing will carefully define what is met by decision superiority and will discuss 8 recommendations emanating from the workshop on actions the U.S. can take to achieve it.

Information System Risk Assessment and Countermeasure Allocation Strategy

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This presentation details work in progress to conduct a Risk Assessment and Countermeasure Allocation Strategy for a military information system. This is a Joint Chiefs of Staff J6 directed effort that includes an inter-agency team with members from the National Security Agency (NSA), Defense Intelligence Agency, and Defense Information Systems Agency. This effort is intended to establish a methodology for conducting risk assessments at NSA that is repeatable, tractable, and defendable. A baseline version of the Global Command and Control System was used to vet the process. The methodologies used for the assessment evolved over time and incorporated information assurance testing, influence networks, fault trees, multi-attribute utility analysis, cost-benefit analysis, and a budget-constrained optimization. The presentation will also address difficulties and insights into the development of a mathematical model that satisfies three different organizations, accounts for positive countermeasure effects on the adversary, includes negative effects that countermeasures impart on the warfighter, and includes both Peace and Wartime scenarios.

Modeling the Decision Quality of Sensor to Shooter (STS) Networks

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At the heart of all information flowing on sensor-to-shooter exists a degree of uncertainty that cannot be engineered out of the network. Failing to understand what these levels are, and what they should be, forces device designers to pursue increased levels of precision, when in fact they should be seeking increased accuracy. At the decision point in such networks, the misperception that precision equals accuracy imbeds a tacit vulnerability in FCS design, which relies upon STS networks to achieve heightened battlespace awareness. This study presents a methodology that captures the decision quality of STS networks involving unattended ground sensors (UGS) and provides design guidance via a novel stochastic sensitivity analysis.

Effects-Based Modernization: Combat Air Forces' Planning and Programming Analytical Tool

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Air Combat Command has completed the development of an analytical methodology that supports effects-based planning and programming for the current Combat Air Forces Program Objective Memorandum, Mission Area Plans, and the Air Force Capabilities Investment Strategy. This briefing will illustrate that methodology and some useful techniques for presenting output.

The methodology evaluates the performance of today's Combat Air Forces against Defense Planning Guidance threats. First, a series of task hierarchies are used to evaluate the criticality of campaign- and system-level capability shortfalls. Then existing and postulated systems are evaluated for their contribution to CAF capability. Next, each system is evaluated to determine which capabilities require improvement based on current performance. Material solutions are then proposed that would reduce or eliminate a system deficiency currently contributing to a capability shortfall. Finally, materiel solutions are scored against a system capability hierarchy whose attributes are system and subsystem performance parameters and whose objective is to maximize system performance across a spectrum of conflict.

Developing an IO Cell Structure for USEUCOM

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In August 2001 the Warrior Preparation Center completed a study for USEUCOM identifying an Organizational Structure for EUCOM's Information Operations (IO) Cell (J-39). The purpose of this study was to capture lessons learned from previous EUCOM operations as they apply to developing a theater IO Cell structure. Given the captured lessons learned, EUCOM wanted the analyst to execute the following: determine an optimal EUCOM IO Cell Structure, identify crisis action requirements, and determine an optimal JTF IO cell structure. This presentation will discuss the methodology followed by the WPC analyst in order to make his recommendation. ORSA techniques used for this study include developing a knapsack optimization model using "What's Best" optimization add-in for spreadsheets and applying techniques used in decision theory. This presentation will focus on the ORSA techniques used to solve the problem.

Space Situational Awareness

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Managing the Electromagnetic Spectrum within a Naval Battle Force

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Over the past few decades, the electromagnetic spectrum has overwhelmingly become the medium of choice for transmitting and receiving information within the Naval Battle Force as well as communicating with elements outside the battle force. In addition, the Navy uses the EM spectrum for surveillance, fire control and Information Operations against potentially hostile forces. Despite this almost total reliance on the EM spectrum for information, the Navy does not currently have an established process for coordinating use of the spectrum as a whole within the Battle Force. Communications plans are developed separate from radar plans and Information Operation plans. This lack of knowledge of the spectrum as a whole has presented problems in the past for the U.S. Navy and was demonstrated in the worst possible way by the U.K. Royal Navy in the loss of HMS SHEFFIELD during the Falklands War. This paper will discuss the current shortfalls in managing the entire spectrum piecemeal, as well as a proposed path toward integration. Methods of coordinating spectrum use with the Joint Task Force will also be addressed.

Using Influence Networks for Information Operations Programmatic Decisions

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A prototype Decision Support System for Coalition Operations (DSCCO) was developed by SPAWAR Systems Center – San Diego to support the Operations Planning Team (OPT) of the Commander in Chief, United States Pacific Command. The

goal of DSCCO was to apply and integrate organizational design concepts and decision support technologies in planning and executing multi-national coalition operations. Within DSSCO, there was a module based on CAESAR II focused on the analysis of alternative Courses of Action (COAs). The capabilities of DSSCO and the CAESAR II / COA module were demonstrated in November 2000 at USCINCPAC.

A group of subject matter expects collaborated in a distributed manner in developing the structure (the relationships between causes and effects) and the data of an Influence Net model representing a key outcome in a hypothetical military operation other than war (MOOTW) in a South Pacific scenario. The Influence net was then implemented using the Campaign Assessment Tool (CAT) developed at AFRL/IF and modified to become a module of CAESAR II. Sensitivity analysis was used to determine which actions could contribute substantially in achieving the desired effects. Those selected actions formed the basis for the construction of COAs, namely, time-phased sequences of these events. An executable model was derived and used to simulate these COAs in the context of the scenario and generate probability profiles (the probability of achieving the targeted effects as functions of time).

The results of these analyses were used to inform the decision makers of the probability range of achieving the desired effects and also to indicate the contribution of a particular action to achieving the effect, i.e., how much influence did a particular action have on the outcome. In a similar manner, CAESAR can be used to weigh the possible effects of different IO programs on the outcomes of the various illustrative planning scenarios of the Defense Planning Guidance. This can provide richer data to IO programmatic decisionmakers upon which to base those decisions.

Multi-Objective Social Network Analysis

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Social networks depict the complex relationships of individuals and groups in multiple overlapping contexts. Influence in a social network impacts behavior and decision making in every setting in which individuals participate. This paper defines a methodology for modeling and analyzing this complex behavior using a Flow Model representation. Multiple objectives in an influencing effort targeted at a social network are modeled using Goal Programming. Value Focused Thinking is applied to model influence and predict decisions based on the reaction of the psychological state of individuals to environmental stimuli.

Modeling Multicommodity Network Flow via Goal Programming

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Goal programming is used to model a minimum cost multicommodity network flow problem with multiple objectives. The network to be analyzed is a single telecommunication network with multiple commodities (e.g., voice, video, data, etc.) flowing over it. Lagrangian relaxation and Dantzig-Wolfe decomposition are used to exploit the pure network structure of a minimum cost multicommodity network flow problem. Lagrangian relaxation captures the essence of the pure network flow problem as a master problem and sub-problems (McGinnis and Rao, 1977). Depending on the model size, a goal programming simplex method can also be used.

All three modeling techniques provide a solution method to effectively analyze the multicommodity network flow problem at hand. Post-optimality analyses provide a variety of options to analyze the robustness of the optimal solution. This mix of modeling options and analyses provide a powerful method to produce insight into the modeling of a multicommodity network flow problem with multiple objectives.

Traffic Analysis in the Cyber World

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This paper reviews the art of Traffic Analysis, a branch of signals intelligence analysis that deals with the study of the external characteristics of communications, and how it can be applied to the cyber world. Through example, it is clear that the methodology used in traffic analysis is applicable to reconstructing and analyzing the networks used by hackers. This paper also briefly touches on how to get information to support this type of analysis, how to use this information for cyber applications, and highlights some areas needing change before this methodology could be employed effectively.

IO Modeling

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Abstract unavailable at printing.

EW & Countermeasures WG-9

Chair: Michael F. Gauble, Lockheed Martin NE&SS
Co-chairs: Greg Gerten, Veridian Engineering; **Harry C. Gornto,** Sverdrup Technology; **Gregory T. Hutto,** 53d Wing; **Daniel R. McGauley,** Northrup Grumman/Amherst Systems; **Cynthia Zessin,** Sverdrup Technology
Advisor: Thomas H. Plank, Sverdrup Technology
GIF 351D

The following abstracts are listed in alphabetical order by principal author.

Combining Live and Virtual Simulations to Operationally Test Electronic Countermeasures Against Modern Surface-to-Air Missile Systems

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This presentation describes preliminary results from a FY 2002 project funded by the Threat Systems Integration Working Group. We explain the design and analysis of a series of experiments conducted in the Air Force Electronic Warfare Evaluation Simulator facility. These experiments were designed to identify important and unimportant hardware-in-the-loop modeling considerations. The specific application is operationally testing electronic countermeasure systems that attack modern surface-to-air missile systems using seeker-aided ground guidance schemes. These missile systems use a hybrid guidance that combines target tracking radar and semi-active seeker inputs within the tracking loop. The tracking loop is closed on the ground and guidance commands are sent to the missile. Because both sources can be used in a guidance solution, the effect of a countermeasure is difficult to observe without actually shooting a missile. Some alternatives to live shots include ground-mounted seeker tests or tests using a seeker flown on a test bed aircraft. But, aside from other difficulties, these solutions significantly limit the ability to fly operationally realistic test scenarios. An option that does not restrict open-air range scenarios, and the one considered here, is to fly against a target tracking radar in a live simulation, record the results, and then use those results in a virtual hardware-in-the-loop simulation that adds a missile seeker. The experimental strategy starts with an initial screening experiment to sift through a set of candidate factors and identify those that could have significant impacts on selected responses. Follow-on experiments resolve confounding, estimate the nature of important main effects, and identify important interactions. The goal is to produce a set of guidelines for operational testers to use when planning, conducting, and evaluating combined tests.

Using Resampling for Design of Experiments With Missing Data

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The usual approach to missing data in factorial experiments is to estimate the level of the missing treatment by fitting a model to the existing data and using this calculated value as a surrogate. Here, we show an alternative using resampling. We compare the two approaches and discuss the differences.

Resampling Statistics and Designed Experiments

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For those of us that teach statistics, one result is clear: most people find the subject difficult and confusing, leading to either failing to apply the correct methods in real world problems or failing to apply statistics at all. Dr. Julian Simon, a founding father in the field of Resampling Statistics (1967), believes that the inherent difficulty in statistics lies in the difficulty of the concepts addressed.

Dr. Bradley Efron, of Stanford University, independently developed a general resampling method he called the "bootstrap", in the 1970s. The basic idea is that all the information we have about a sample is contained in that sample; we have no a priori knowledge that the sample came from a specific type of distribution. Since that's true, let's treat the sample as the proxy universe that all samples come from. Everything else in bootstrap follows from that simple idea. Jerome H. Friedman, a Stanford resampling statistician said: "Eventually, it will take over the field, I think.'" (New York Times, Nov. 8, 1988, C1, C6).

We are in the process of determining whether Dr. Friedman is correct. Design of Experiments has revolutionized testing at the 53rd Wing, Eglin AFB, but we continue to struggle with generating enough practitioners of the method to address all the tests undertaken by the Wing. The chief difficulty lies in teaching the foundations, mechanics and extensions of the Analysis of Variance (ANOVA) to analyze the sample (now 2-3 weeks). This paper represents a status report on a work in progress – determining how the attractive aspects of resampling statistics can be applied to the multivariate problems of experimental design. We will summarize the background of resampling statistics, and the classical and resampling approaches to analyzing multivariate data.

Herding Cats—Leading an Operations Analyst Reinvention Effort in a Dynamic Electronic Warfare Group

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As Ralph Waldo Emerson noted, "Fear always springs from ignorance." Change is generally a feared and fought aspect of operations in an office or unit, especially when the changes are instituted by superiors and forced downward to the lower levels. If the workers do not understand the need or purpose for the change, it will probably never be fully adopted at the lower levels. Without adopting the changes, an office or unit cannot incorporate new ideas, methodologies and processes that could increase efficiency and productivity.

This presentation documents and discusses some of the these issues in aspects of the 53rd Electronic Warfare Group (EWG), as it adopts and incorporates a different (not new) approach for conducting Test and Evaluation in a constantly changing environment. The leadership of the 53 EWG enthusiastically adopted this methodology, called Experimental Design; however, its incorporation as a standard testing methodology was not openly accepted at the lower levels. As a result, many man-hours were expended educating members of the lower levels in this new methodology. This presentation will deal with many aspects of incorporating a large change in a dynamic unit, including the perils and pleasures of reinventing test processes from traditional methods, clarifying the vision, focusing the efforts, squelching rumors, ensuring accurate communication, organizational inertia and promoting acceptance at all levels.

Using Resampling and Bootstrap for Teaching Statistics

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We'll discuss how and why we incorporate resampling and bootstrap techniques into the 36 Electronic Warfare's training program for operational analysts. Statistics, both in practice and teaching, traditionally has relied on assumptions of normality or other underlying distributions, as a way of easing computational burdens. This made sense when calculation was indeed a burden, but with the advent of substantial computing power, this is no longer the case. Further, while distributional assumptions eased calculation, they increased the conceptual burden on the student and researcher alike. One result has been that statistical testing has become complex enough that no one but seasoned professionals can be counted on to consistently choose the right test for a given situation. Resampling and bootstrap -- nonparametric approaches -- are key to trading conceptual burden for computational burden, making statistics far more intuitive.

Sample Size Estimation Using Bootstrap

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One typically needs an estimate of how many samples should be collected, even before a test starts. Sample size calculations for factorial tests typically make distribution assumptions that may not be warranted. We will approach sample size calculation using bootstrap, a distribution-free technique, and compare it to more common approaches.

Resampling Statistics and Designed Experiments

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Frequently, data from factorial experiments violate ANOVA assumptions. In such situations, one can still obtain confidence intervals and significance levels if nonparametric methods are used instead. We will show several examples of the use of resampling techniques to replace ANOVA. Such an approach is conceptually simpler than ANOVA and easy to implement, yet it is very close to Fisher's original construct for analysis of multifactor data.

Unmanned Systems WG-10

Chair: James R. Johnson, USAF UAV Battlelab
Co-chairs: Lee Gilbert, JUAV JT&E
Gary Engel, Boeing
Frank Briglia, Teledyne Brown Engineering
Advisor: Chuck Taylor, OSD
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The following abstracts are listed in alphabetical order by principal author.

Analysis of Alternatives for a Tactical Hybrid UAV/UGV

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A team of West Point cadets investigated the feasibility and utility of an unmanned tactical reconnaissance vehicle with both flying and ground movement capabilities. This was done in response to a set of candidate system requirements from the Advanced Systems Directorate at Redstone Arsenal, with a target system deployment date of 2020. The team researched the underlying technologies and their likely future directions and looked at the ways such a system could be used, comparing it to single-purpose UAV and UGV systems. The analysis identified the most promising system concepts and concludes by recommending directions for future development.

Design Principles of Unmanned, Distributed Combat Forces

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Defense community innovators have proposed concepts that use cutting-edge technologies to solve long standing military challenges, including destruction of time-critical targets, theater-wide surveillance and power projection and access to contested littorals. These concepts assume great benefit from networking of unmanned, distributed force, but a useful definition of networked forces does not yet exist and the advantages of networking have not been fully and convincingly expressed. This document defines and describes how "Distributed Forces" provide Information Age advantage and offers some force-wide design principles for future unmanned distributed forces.

Automatic Target Cueing (ATC) tool for UAVs Synthetic Aperture Radar (SAR)

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Abstract unavailable at printing.

U.S. Japan Bilateral Study - Notional Sensor Platform

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USCINCPAC is involved in continuing analysis with allies in the Pacific region. Last year, USCINCPAC and the Japanese Joint Staff Office (JSO) initiated a new bilateral study. The study is a bilateral joint assessment of the benefits provided by a high altitude long endurance unmanned platform referred to as a Notional Sensor Platform (NSP) in conducting maritime surveillance of the Sea of Japan and its littorals to monitor ship traffic and support humanitarian assistance in natural disasters. This is the first analytic effort involving USCINCPAC and Defense Agency, Japan (JDA) since the Bilateral Sea Lines of Communications Study was completed n 1987. The procedures developed during this study will provide the basis for future bilateral analyses.

NSP provides a pseudo-satellite capability owned at the operational level. This provides a flexible sensor capability that can be tasked to respond to other requirements such as natural disasters. The Extended Air Defense Simulation (EADSIM) is the primary model for this analysis. Detailed command, control and communication of the NSP were modeled in EADSIM to model the collection, processing and dissemination of imagery data. Two different command and control structures were modeled as well to measure the impact of Japanese Maritime Self Defense Force (JMSDF) C2 structure compared to a Joint C2 structure.

NSP may contribute greatly to collection of intelligence data for the Sea of Japan and its littorals. However, NSP's demands on the regional Intelligence, Surveillance, and Reconnaissance (ISR) infrastructure may be too high for practical use. This study will provide a preliminary assessment of NSP use, and may lead to more detailed analyses if relationships between NSP benefits and demands are favorable. USINCPAC and JSO have coordinated a plan to develop the database, scenario, and objectives; execute model runs; and analyze output data.

This briefing will provide a brief description of the study objective, scope, approach, methodology, database and emergingn results of this effort. This briefing describes two potential scenarios for the use of an NSP: maritime surveillance, and humanitarian assistance in a disaster. It concludes with estimates of NSP benefit/demand relationships.

A Simulation Study to Quantify Targeting Latencies

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There are two basic ways to control an Unmanned Combat Air Vehicle (UCAV) as it searches for targets, allow the UCAV to act autonomously or employ man-in-the-loop control. There are also two target sets of interest: fixed or mobile targets. This research focuses on UCAV-based targeting of mobile targets using man-in-the-loop control. In particular, the

interest is in how levels of satellite latency or signal degradation affect the ability to accurately track, target, and attack mobile targets. This research establishes a weapon effectiveness model assessing targeting inaccuracies a function of latency and/or signal degradation. The research involved three phases.

The first phase in the research was to identify the levels of latency associated with satellite communications. A literature review, supplemented by interviews with UAV operators, provided insight into the expected range latency values.

The second phase of the research identified those factors whose value, in the presence of satellite signal latency, could influence targeting errors during UCAV employment.

The final phase involved developing and testing a weapon effectiveness model explicitly modeling satellite signal latency in UCAV targeting against mobile targets. This phase included an effectiveness analysis study.

This presentation includes background material on the latency issue with UCAV-based targeting, an overview of the effectiveness model and a presentation and discussion of results obtained using the effectiveness model.

Networked Unattended Ground Sensor Fields - Tradeoff Study and Configuration Rules

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We present a methodology capable of illuminating key underlying relationships that exist within networks of unattended ground sensor (UGS) fields in order to quantify generalized network configuration rules and perform tradeoff studies in support of the Army Research Laboratory (ARL) - Sensors and Electron Devices Directorate. Our effort in this vein focuses on producing insights that will facilitate accurate combat simulation modeling of a variety of UGS fields (magnetic, acoustic, seismic, and IR image), thereby enabling ARL to prescribe both the ideal number and mix of sensors to employ within the Future Combat Systems (FCS) operational context.

Moving Target Indicator (MTI) Applications for UAVs

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Shaping Future Naval Warfare with Unmanned Systems

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NAVSEA Panama City unveiled a comprehensive vision for unmanned systems that will shape the future of Navy and DOD forces and augment force capabilities. This vision, described in CSS/TR-01/09, focuses on issues of affordability, logistics, and automation; these issues are key to broad scale acceptance and use of unmanned systems. Affordability is a achieved through the implementation of "smart" standards and modularity across a family of unmanned system platform types (air, surface, ground, and underwater). Multiple use mission packages on a limited number (for example 3 standard sizes) of unmanned system platforms will take advantage of economy of scale and lower overall costs. Logistically, the global shipping infrastructure, not just combatants, will insert the unmanned systems into theater operations in large numbers. This paper explores operations research challenges and questions that must be addressed to explore the envisioned broad use of large numbers of unmanned systems in four relevant Naval concepts of operation scenarios.

Global Hawk UAV, Development and Flight Testing Programs

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The Global Hawk Unmanned Aerial Vehicle (UAV) will provide battlefield commanders near-real-time, high-resolution, reconnaissance imagery. Flying at extremely high altitudes, Global Hawk can survey large geographic areas with pinpoint accuracy, to give military decision-makers the most current information about enemy resources and personnel.

Global Hawk has a wingspan of 116 feet and is 44 feet long. It can range as far as 12,000 nautical miles, at altitudes up to 65,000 feet. Its cloud-penetrating, Synthetic Aperture Radar/Ground Moving Target Indicator, Electro-Optical and Infrared sensors can image an area the size of Illinois (40,000 nautical square miles) in just 24 hours. Through satellite and ground systems, the imagery can be relayed in near-real-time to battlefield commanders.

Global Hawk began as an Advanced Concept Technology Demonstration (ACTD) in 1995. An ACTD provides war-fighters a rapidly-developed prototype that can be used for Military Utility Assessment (MUA) and early operational activities. In March 2001, Global Hawk entered the Engineering, Manufacturing and Development phase of defense acquisition. Global Hawk currently is undergoing flight-testing at the Air Force Flight Test Center (AFFTC) at Edwards Air Force Base, Calif., with over 1200 hours flown during more than 100 successful sorties.

Simulation-based Technology and Investment Planning Experiment (STIPE) Campaign Modeling as Applied on the SensorCraft Technology Assessment

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The goals of STIPE are to reduce the time and cost for developing and maturing promising Uninhabited Air Vehicle (UAV) technologies, to integrate the technologist and the warfighter into the Science and Technology (S&T) acquisition process, and to provide analytical input into the Air Force S&T planning process. STIPE combines engineering-level modeling, design and analysis tools, mission- and campaign-level simulations, and cost analysis tools in a simulation environment to provide analytic information to support investment decisions in the Science and Technology arena. This simulation environment will provide the capability for researchers to evaluate the impact of different UAV technologies in a warfighting environment, providing a link between AFRL technologies and warfighter mission needs.

The STIPE simulation environment is being applied on the SensorCraft Technology Assessment as a proof of concept. AFRLs' SensorCraft initiative is an advanced multi-sensor UAV for standoff ISR. This presentation focuses on the campaign level analysis performed in support of the SensorCraft Technology Assessment. The goal of the campaign analysis is to provide operational measures of merit for return on investment (ROI) analysis to identify promising candidate SensorCraft concepts. The variables derived from the candidate technologies include the basing concept, air vehicle endurance, air vehicle RCS, mean time between critical failure (MTBCF), mean time to repair (MTTR), ground moving target indicator/tracker (GMTI/T) performance, spot synthetic aperture radar (SAR) performance, and air moving target indicator (AMTI) performance. The primary measures of merit at the campaign level are kills by target type and campaign duration required for operational task objectives.

Military Environmental Factors WG-11

Chair: Gary McWilliams, Army Research Laboratory
Co-chairs: Suzanne Birdwell, Planning Systems, Inc
Danny Champion, TRAC-WSMR
Niki Deliman, Engineer Research and Development Center-WES
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The following abstracts are listed in alphabetical order by principal author.

JWARS Terrain Roughness and Probability of Line-of-Sight Modeling Research

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The Joint Warfare System (JWARS) is a constructive, analytic stochastic simulation of joint theater level warfare. As with other military simulations, roughness and line-of-sight (LOS) play important roles in many aspects of combat simulation such as tactical mobility, direct fire and indirect fire adjudication, and target sensing and tracking. This paper reports on a new approach to generating measures of roughness and probability of LOS (PLOS) suitable for JWARS application. The approach extends work done by TRADOC Analysis Command in relating roughness to PLOS. The extension involves: (1) developing a corrected measure of roughness as a function of range of interest by subtracting out a "soap film" substrate to remove unintended effects of general terrain slope, (2) fitting the corrected roughness empirical data to a two-parameter parametric curve, (3) fitting empirical PLOS curves for various observer heights to a second two-parameter parametric curve involving the composition with the corrected roughness curve. The result is a four-parameter composite model that provides very satisfying fits to empirical PLOS data. Future extensions are planned to provide probabilities of LOS conditional on previous observer-target LOS status, conditional on target and observer non-random positioning, and to address issues of desirable PLOS repeatability.

Synthetic Weather Forecasting for Naval Logistics Decision Simulation

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The Office of Naval Research is sponsoring development of a Naval Logistics Wargame Simulation (LWS) for the analysis of sea-based logistics concepts of operations (CONOPS). Simulated Naval logistics planners consider environmental effects when generating availability estimates for logistics support. High sea state, strong winds, extreme temperatures, and degraded visibility degrade or curtail cargo transport operations. Perfect knowledge of weather is not available, so the LWS projects a perceived weather picture for decision-making by the simulated logistics planners. Fuzzy logic is applied to simulate asset availability decisions in gray go/no-go areas. A chess-like lookahead explores possible reorderings of maneuver requirements to achieve logistics needs. The LWS uses a stochastic shift matrix to generate forecasts by shifting ground truth synthetic weather in time. This algorithm generates forecasts that generally improve as the date of the forecast becomes closer and that exhibit the correlated errors observed in actual forecasts. The algorithm involves six parameters, five of which are used to calibrate the model to observed forecast performance. The remaining parameter is used to reflect the quality of the weather forecasting system. The resulting synthetic weather forecasting model may be easily integrated into any constructive simulation employing an environmental server to provide synthetic weather.

The Expanded Role of Concept Modeling in Simulation Development Including the Natural Environment Subsystem

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This presentation describes the application of the Simulation Engineering Concept Model (SECM) to analyze the Navy's Probability of Raid Annihilation (P_{RA}) Federation. The SECM is based on object-oriented system engineering practices and has evolved from the Environment Concept Model (ECM). The ECM was initially used to develop a consistent and sufficient environmental representation for the Navy's Integrated Ship Defense program. Historically, treating the natural environment only as input data has ignored the analysis necessary to determine the appropriate environment representation required by a simulation. When the ECM was applied to the P_{RA} program it revealed that the natural environment must be treated as a critical subsystem in the system representation. To be effective, the simulation design must identify and trace all subsystems as a part of the FEDEP. The SECM has evolved concept modeling to form the basis for this process for all steps in the FEDEP.

Embedded Simulation System for SMART

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The U.S. Army's Tank-Automotive Research, Development and Engineering Center (TARDEC) Embedded Simulation (ES) team, has developed an Embedded Simulation System that interfaces with advanced vehicle hardware and software as part of the Inter-Vehicle Electronics Suite (IVES) Science and Technology Objective (STO). The ES system allowed the IVES STO to field test advanced concepts such as Indirect Vision Driving, Drive-By-Wire, Voice Recognition, 3D Audio, Head Tracking and advanced crewstation design using simulation to provide stimulation to crewmen. Technologies that were simulated to provide workload analysis for the two- man crew included Automatic Target Recognition (ATR), Automatic Target Tracking (ATT), C2, integrated OPFOR and Friendly CGF and Battlefield Visualization.

The ES system has also been integrated with AMC RDEC Federation. The RDEC Federation provides full spectrum modeling and simulation services to any customer. Full spectrum ranges from engineering level models through virtual prototypes onto battlefield simulations. All models are validated to the system they represent through close interaction between the modeler and system developer. All simulation scenarios are based upon realistic circumstances, run real-time, and generate semi-automated forces as required. Each RDEC (and ARL and STRICOM) brings a robust suite of supported models within their area of technological and subject matter expertise. These areas include missiles, armaments, communications, aviation, sensors, vehicles, and command and control. The use of ES System allows the customer to evaluate advanced concepts in the latest crewstation designs with the latest interfaces.

The ES system is being enhanced and used as part of the Crew integration and Automation Testbed (CAT) Advanced Technology Demonstration (ATD) and Robotic Follower ATD in support of the FCS program. A field demonstration is planned for February 2003.

When Good Terrain Goes Bad

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Those who use digital elevation models (DEMs) generally assume they are using good quality data. Even if a reputable provider is paid to build a high-resolution database to certain specifications, how does the user really know the quality of the data. This is a case study where a very high-resolution, high-accuracy DEM was required and purchased. However, procedures used on the initial source data to develop the final product resulted in data inadequate for its intended application. This presentation describes a ground-truth validation process that was instrumental in identifying various flaws in the DEM which were, in turn, acknowledged and corrected by the provider. Also discussed will be the discrepancies in line-of-sight when using a poor DEM.

Military Environmental Factors WG-11

Integration of Urban Characterization, Munitions Effects, and Threat Assessment for Ground Vehicle Movement Planning in Urban Environments

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Transition to the Objective Force will involve development and assessment of capabilities for operations in urban environments as U.S. Military involvement in urban conflict and peacekeeping operations continues to increase. Current representation in modeling and simulation (M&S) is deficient; it is imperative that developing M&S realistically portray these environments to facilitate advanced concept exploration, doctrinal development, force structure assessment, and materiel alternatives. Rubblizing associated with structural weapons effects is a primary consideration and potential detractor to mission accomplishment, particularly in the area of movement and maneuver, to include route finding. Identification of urban/structural features and attributes is a key component for structural weapons effects algorithms needed to generate the rubble footprint. The U.S. Army TRADOC Analysis Center, U.S. Army Engineer Research and Development Center, and U.S. Army Materiel Systems Analysis Activity are currently involved in an FY02 collaborative project to incorporate urban environments, associated realistic munitions effects, ground vehicle movement characteristics, and routing with consideration of movement rates and threat locations. Major components of the project include characterization of urban environments, development of a structural weapons effects module and debris field distribution, expansion of the Standard Mobility API to incorporate effects of rubble obstacles, development of associated route finding algorithms, and implementation with COMBAT^{XXI}.

Applicability of Target Acquisition Modeling to the MOUT Environment

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The overall objective of this study is to conduct the foundation research that will guide the enhancement of the NVESD ACQUIRE acquisition model to allow the effectiveness of MOUT to be determined in a force-on-force context. The main component of the study identified at this point is the detection of targets and visual assessment of their threat level. It is clear that the technical approach to this project will include several sub-tasks such as:

1. Determination of those activities that enable observers to discriminate between friendly, threat and non-combatants entities.
2. A model to predict probabilities that these activities may be recognized, given the physical environment in which they take place.
3. Estimation of the visual/thermal characteristics needed by existing sensors to input to such a model.

Since the ACQUIRE model will be central to the product developed by the project, it will be necessary to review and document those assumptions and constraints associated with it, since some of them may be violated by using this model in a manner for which it was not designed. Some of the potential problems associated with using the ACQUIRE model directly in a MOUT environment will be discussed.

Balloon-Ring, Radar, and Aircraft Measurements of Refractivity Turbulence

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Results of a new measurement platform for optical and mechanical turbulence observations are presented and discussed. The platform is a polyethelene tube shaped as a ring with a pressure relief valve. The "ring" is actually 8-sided with a

diameter of about 30 feet and trails a balloon with several risers. Several fine wire sensors (1 1/4 μm diameter) are mounted at various spacings to measure high speed temperature and velocity fluctuations. From these measurements the refractive index structure parameter (C_n^2), inner scale (l_0), outer scale (L_0), the eddy dissipation rate (ε), and other parameters of interest can be estimated. Measurements are compared to simultaneous observations taken with a VHF radar estimating the same parameters. Several questions are addresses that are important for laser propagation such as: a) Is the atmosphere isotropic for the scales of interest? b) Is the turbulence Kolmogorov under various atmospheric conditions, or how often is the structure function represented by the $r^{2/3}$ law? c) What are the profiles of inner and outer scale? d) Does wake contamination affect thermosonde measurements? and e) Does fine scale structure within the scattering volume sense by a radar affect C_n^2 and ε estimates? A program using the same fine wire sensors on an airplane will be discussed. The importance of determining the path variability of C_n^2 and l_0 for interpreting scintillometer measurements over long paths will be presented. The site discussed is the Airborne Laser Advanced Concepts Testbed (ABL ACT) that is located on White Sands Missile Range, NM. A 52.4 km propagation path is utilized between two mountain peaks.

Cryogenic Abatement of Spill-Induced Toxic Vapor Plumes: A Feasibility Study

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The remediation of volatile toxic liquid spills and abatement of toxic plumes is of increasing concern. Current methodology for emergency remediation of chemical spills usually involves evacuation plus the use of physical methods, such as barriers (dikes) and absorption using clay and removal with heavy equipment, and when applicable, bio-remediation methods or chemical methods are used to neutralize the spilled chemical. Only in recent years has frozen soil barrier technology been used for environmental remediation of contaminated soil. To my knowledge, none of the current methods immediately and specifically address the abatement of the vapor plume induced by the spill. The feasibility study, by using calculated estimates and computer modeling, indicates that the use of inexpensive cryogenic liquids such as liquid nitrogen (LN2) shows promise in the abatement of toxic volatile materials spilled as liquids into the surface layer. Chilling and/or freezing of the spilled chemical at the surface minimizes the evaporation and diffusion of the liquid (or sublimation of solid), and therefore, the plume concentration and volume. Introduction of spray (water or other liquid) into the plume to directly washout the chemical and to form a frozen, impermeable crust on top of the spill area may further reduce the plume concentration and volume.

Enabling Technologies of the Integrated Natural Environmental Authoritative Representation Process (INEARP) Implementation

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The Defense Modeling and Simulation Office (DMSO) Environmental Representation Technology Area, in conjunction with the DoD Modeling and Simulation Executive Agents (MSEAs) for the Authoritative Representation of the Atmosphere and Space, Ocean and Terrain, is sponsoring development of enabling technologies to implement the Integrated Natural Environmental Authoritative Representation Process (INEARP). The MSEAs and DMSO have developed an INEARP implementation as a cooperative effort to demonstrate how users of M&S technology will acquire authoritative environmental representations using an effective, readily accessible process and supporting technical infrastructure. The INEARP will provide the capability to rapidly generate a fully integrated environmental representation to include aspects of ocean, atmosphere, space and terrain that is internally consistent, cost effective, and authoritative and meets the requirements of the warfighter. This presentation will offer an update on the progress of current efforts.

Military Environmental Factors WG-11

Assessing Effects of Enhanced Fidelity for Ground Vehicle Mobility in Combat Models

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As computer systems exhibit greater computing power, they provide combat model developers the capabilities to enhance the fidelity of their simulations by improving the fidelity of underlying algorithms. Movement, such as ground vehicle movement, is one of the basic battlefield functions and is portrayed at differing levels of fidelity across M&S. Ground vehicle movement is limited by the terrain/environmental factors present in reality, but this fact is not necessarily reflected in current simulations. The need to account for such effects has been acknowledged by the community and is being incorporated in developing simulations. As simulation fidelity is enhanced, however, it is also important to address the question of what increased or decreased fidelity representation buys the user/analyst.

This paper will address effects of improving ground vehicle mobility representation in entity-level M&S by incorporating mobility limiters, utilizing the recent integration of the standard mobility application programmers interface, STNDMob API, with COMBAT^{XXI}. The development and integration were conducted largely by the US Army Engineer Research and Development Center and the US Army TRADOC Analysis Center – White Sands Missile Range. COMBAT^{XXI} is the Army's next-generation brigade and below entity level analytical model. The standard mobility application programmers interface, STNDMob API, allows entity level models to use terrain limited speed factors and is based on the Army's standard mobility model, NATO Reference Mobility Model (NRMM). This integration has revealed some potential impacts on simulation outcomes resulting from dynamically limiting the speed of vehicles and restricting areas of operation based on environmental conditions versus utilizing command ordered or static speeds and will form the basis for the study.

Experimental evidence for the differential effect of temperature on bulk and vicinal water: Implications for terrain state and signature physics.

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Soil physical properties have long been correlated with soil texture. Recent studies indicate that the effect of temperature on the physical and electromagnetic properties of water near the surfaces of soil particles differ markedly from those of bulk water. If verified, these phenomena suggest that description of the physical and electromagnetic soil properties should include temperature and specific surface, which, in principle, would lead to immediate improvement in the Army's ability to sense remotely and model the mobility of soils and roads in the natural environment. These results would have implications for the types of soil data to be included in the next generation of Army GIS databases.

New Transmission Algorithms for Modeling Obscurants in Urban Environments

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The behavior and effects of obscurants in complex and urban domains continues to be a difficult modeling challenge. Complex non-uniform wind flow and turbulence within a surface boundary layer represented by buildings in an urban environment or trees in a forest canopy introduce complexity that cannot be handled in current obscurant models. The usual representation of obscurant clouds as simple plumes and individual puffs is inadequate. New models of transport and dispersion of obscurants and other aerosols in these flows propose that cloud concentrations be tracked as an ensemble of many puffs released from the source. Therefore, in this paper we introduce new efficient algorithms for computing line of sight transmission through large numbers of puffs of different sizes and locations. The methodology can also account for buildings and walls that partially intersect the cloud and "reflect" the obscurant or aerosol back out into the street flow.

Can Pre-flight Physics-Based Infrared Synthetic Scene Simulation Enhance Army Aviation Mission Effectiveness?

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Aviators rely heavily on Forward Looking InfraRed (FLIR) imagery to navigate and to rapidly and accurately detect and identify targets. Weather and weather impacted terrain and targets can significantly alter terrain-target infrared contrast relationships impeding an aircrew's ability to effectively use FLIR imagery for mission accomplishment. Weather affected FLIR performance potentially increases the Army aviator's exposure to enemy threats and counterattacks, and ultimately decreases system lethality and survivability. Pre-flight physics-based infrared synthetic scenes can mitigate the impact of weather by portraying the weather impacted terrain-target infrared contrast accurately.

The U.S. Army Engineer Research and Development Center (ERDC), the Air Force Research Agency (AFRA), and the U.S. Army Aviation Test Directorate, Operational Test Command tested the utility of the Infrared Target-scene Simulation Software (IRTSS) system as a mission planning and rehearsal tool for AH-64 Apache attack aviation. Pre-flight infrared synthetic scene mission enhancement was quantified using metrics based on Battle Position (BP) rankings, as compared to the rankings of a Standardization Instructor Pilot (SIP), target detection times, number of target false detects, and number of target non-detects. Questionnaires provided a qualitative assessment of the 'value' of pre-flight synthetic infrared scenes as judged by Army aviators.

Two groups of fifteen Apache pilots participated in the test to determine the impact of pre-flight physics-based infrared synthetic scene simulation on Army aviation mission effectiveness. One group of test subjects received the current pre-flight briefing tools, while the second group received current briefing tools plus IRTSS generated scenes representing the Apache Target Acquisition Detection Site (TADS) imagery consistent with the mission Fragmentary Order. U.S. Army Aviation Test Directorate, Operational Test Command/ATEC conducted the formal analysis. Researchers at CRREL conducted additional analysis. The BP correlation between the test subjects for each group and the SIP, the target detection times, including procedures to account for false and non detects, and the number of false and non-detects was used to ascertain the benefits derived from using pre-flight infrared scenes on mission effectiveness. The analysis of the quantitative and qualitative data supports the conclusion that pre-flight physics-based infrared synthetic scene simulations enhance Army aviation mission effectiveness.

Progress in Development of a Thermal Strain Prediction Model for Warfighters

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Weather conditions in the dismounted infantry battlespace can pose significant challenges to warfighter health and performance. As our military force structure becomes increasingly tuned to rapid deployment scenarios anywhere in the world, there is a growing need to fully develop and validate predictive modeling tools that allow timely assessment of the physiological effects of potentially extreme local environments. Future Army systems envision the application of these models in military operational settings, and development of capabilities to quantify individual warfighter thermal strain in both real-time and prognostic modes are identified in the Operational Requirements Document (ORD) for Land Warrior. This work is focused on development of a deployable mathematical model that reflects our understanding of minute-to-minute human physiological responses across the full range of environments from extreme cold to extreme heat, in a context that considers individual warfighter physical characteristics, clothing type, and mission driven rates of energy expenditure. This presentation describes progress we have made in model integration and in validation efforts using data from laboratory studies and field studies conducted as part the Warfighter Physiological Status Monitoring (WPSM) program.

Quantifying the Utility of Satellite-Derived Soil Moisture Information for Army Combat Operations

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Identifying and quantifying the potential benefits associated with newly proposed or planned military systems is an integral part of the conceptual and developmental phases of the DOD acquisition process. Quantifying the benefits for Intelligence, Surveillance, and Reconnaissance (ISR) type systems are especially challenging since no direct connection often exists between the ISR information and how it affects some of the traditional combat Measures of Effectiveness (MOEs). To address this issue, Joint Semi-Automated Forces (JSAF), an entity-level combat simulation model, is used to perform a series of simulations that effectively quantified how ISR-like information affected combat outcomes based on traditional MOEs. The ISR information we examined was soil moisture, which is valuable to the Army because of its impact on mobility and trafficability. The soil moisture conditions that we modeled emulate the measurement capability expected to be available from the National Polar-orbiting Operational Environmental Satellite System (NPOESS). The Departments of Commerce and Defense are jointly funding the development, operation and maintenance of NPOESS, which uses the measurement of soil moisture as one of its key performance parameters. The NPOESS Integrated Program Office is using our results to help quantify the tactical utility the Army can acquire when considering such data. The results, which compare the utility of using NPOESS soil moisture information in relation to legacy sources, were derived from over 60 simulation runs that included a combination of different military scenarios and soil moisture conditions. As one progresses from dry to a wet slippery condition, the improved spatial and temporal resolution of the NPOESS data results in marked contrasts in the MOEs (maximum momentum, attrition, and fuel consumption) for these simulations. These results demonstrate that the Army can significantly benefit from the use of the NPOESS soil moisture data in its planning and execution of combat operations.

ISOON and SMEI: Two New Resources for Assessing the Space Environment

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The Improved Solar Optical Observing Network (ISOON) and the Solar Mass Ejection Imager (SMEI) are two new instruments that will become available in the near future for detecting and tracking solar phenomena that have the potential to gravely affect DoD assets in space and on the ground. ISOON is a semi-autonomous network of ground based solar telescopes that will be deployed beginning in 2003 and will patrol the Sun for solar flares and other indicators of solar activity for use by space weather forecasters. The SMEI instrument will be launched into sun-synchronous polar orbit in late 2002 or early 2003 and will, for the first time, be able to detect and track Coronal Mass Ejections (CMEs) as they propagate through interplanetary space by providing photometric, whole sky white-light images at a 96-minute cadence. SMEI will allow for dramatically improved forecasts of the onset, duration, and strength of CME-related geomagnetic storms that affect spacecraft, navigation, and communication systems. The principals of operation of ISOON and SMEI will be presented, along with their current status and implications for military operations research.

Weather Access for Visualization and Exploitation (WAVE)

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The Weather Access for Visualization and Exploitation (WAVE) initiative will provide a web-enabled interface for accessing XML encapsulated decision quality weather data for warfighter Command and Control (C2) and mission planning applications. These applications currently rely on human mental ingestion and exploitation of pictorial images of weather data. Interpreted data must be manually entered into the warfighter and C2 applications. The C2 Battlelab, in partnership with Air Force Research Lab, and with the support of the Electronic Systems Center, will develop an Application Program Interface (API) to the Joint Weather Impact System (JWIS). Utilizing state of the art XML tags, WAVE will enhance the Environmental Data Cube in JWIS, and build a business-to-business style API allowing warfighter and C2 applications to access decision quality, geo-referenced weather data. The capabilities of WAVE will be demonstrated within the USAF C2 Battlelab's Master Air Attack Planning Toolkit to access weather data during Joint Expeditionary Forces eXperiment 2002 and Millennium Challenge 2002.

Obstacle Crossing Performance of Vehicles

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Obstacles can disrupt, impede, and otherwise influence the outcome of military operations, understanding when and how fast an obstacle can be crossed is required to increase Army model and simulation fidelity. Obstacles other than minefields, such as ditches, berms, cuts and fills, craters, etc can be either natural, man made or reinforced, and depending on vehicle capabilities, these obstacles may be crossable, but at a greatly reduced speed. Obstacle crossing speed is also an issue when comparing performance between wheel and tracked vehicles, additionally the performance of small robotic vehicles must also be considered in emerging simulations. This presentation describes current efforts by the Engineer Research and Development Center (ERDC) to enhance vehicle speed predictions during an obstacle crossing in a SAF environment.

The NATO Reference Mobility Model II (NRMM II) is an Army standard model for determining vehicle mobility performance, primarily by predicting maximum vehicle capable speeds. The effect of a linear obstacle on maximum speed is determined by using two look-up tables. The first is a table of average and maximum (resistance to motion) forces and minimum clearances based on standard obstacle descriptions. If the minimum clearance is greater than the vehicle clearance, the maximum force is used to determine if there is enough available traction to cross the obstacle. If either the clearance or maximum traction tests fail, NRMM II predicts no-go. Otherwise, the average force is added to the total resistance, which is used to calculate the maximum vehicle capable speed across the obstacle. The second table contains vehicle speed versus obstacle height and is used to limit speed due to vehicle and driver acceleration tolerance (2.5g). These tables are in the individual NRMM II vehicle data files, and are produced using 2-dimensional vehicle dynamics software (OBSMOD and VEHDYN II).

The extraction of this information, obstacle description requirements, the implementation of this high resolution data/model into a lower resolution SAF environment are discussed.

Mobile Environmental Effects Technology

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Military operations and weapon systems are adversely affected to some extent by the environment, even those advertised as "all weather capable". Thus, it is essential to provide advance warning of these impacts to commanders, and end users, such that intelligent decisions can be made regarding what weapon systems or tactics to employ as well as where and when to employ them. The U.S. Army Research Laboratory (ARL) has developed a number of automated software applications designed to provide environmental information and environmental effects to the end user. Much of this technology has been transitioned to fielded Army automated command and control systems. Recent research has focused on the technology development for mobile computing devices such that lower echelons can eventually have access to this vital intelligence. In addition to an environmental effects application, technology has been developed to provide acoustic propagation effects, weather alerts and even a capability to enter and transmit a local weather observation back to a server. This presentation will focus on the applications that have been developed for the mobile device.

Military Environmental Factors WG-11

The Implementation of a Mesoscale Meteorological Model (MM5) for the Production of Simulation Scenarios Ranging from Mission Planning and Rehearsals to Long -Term Simulations

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The Department of Defense has been involved in modeling and simulation activities for many years. Recent economic constraints and technological improvements have resulted in a strong, renewed commitment to modeling and simulation as the pathway to improved capabilities and decision making. An important aspect of this renewed commitment is to incorporate the effects of the natural environment (air, space, oceans, and terrain) into modeling and simulation activities. The DoD Modeling and Simulation Executive Agent for Air and Space Natural Environment (ASNE) serves the modeling and simulation community as subject matter experts for air and space natural environment modeling and simulation databases (including relevant standards), dynamic processes, and other applications. Some of ASNE's past projects provided historical hourly time-stepped scenarios (ground truth) of meteorological conditions. In 2001 and 2002 ANSE supported efforts to provide perceived truth (forecasts) using MM5 modeled output. The output can serve as perceived truth (PT) when required or as stand alone scenario to feed operational systems (Army Battle Command System, AMIS, NTFS, etc.). The output is intended to be loaded onto operational weather systems like IMETS, OPSII, and TEDS for execution with MM5 forecast fields for short range mission planning and rehearsals and any simulation system requiring perceived truth meteorological conditions.

Target Acquisition under Degraded Atmospheric Conditions: Parametric Curves for Wargames

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Applying weather to wargames is always problematic - detailed physics calculations are required involving significant amounts of computer time; even the simplest of atmospheric calculations frequently takes too long. Since wargames, particularly aggregate games, cannot afford this overhead, alternate approaches must be devised.

Recently progress has been made in this area by applying the Integrated Weather Effects Decision Aid (IWEDA) rules. An example of such a rule would be "Winds exceeding 10 knots precludes helicopter takeoff/landing." While this rule is straightforward, rules dealing with target acquisition are not always so clear-cut. Variables for target acquisition include not only the target state and sensor chosen, but also the state of the weather - the presence or absence of clouds, precipitation within the last 6 hours, aerosol type for visibility determination, time of day, time of year and so on.

Using algorithms contained in the Target Acquisition Weapons Software (TAWS), we are constructing parametric curves relating the above-mentioned variables to target and sensor type. A brief overview of TAWS along with the latest results from this methodology will be presented.

TRAINED CELL: A Multi-modal Biosensor and Decision System

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By their fundamental nature, the challenges posed by biological and chemical weapons of mass destruction (BCWMD) – also known as Mass Casualty Weapons – and emerging infectious diseases (EID) are of the utmost concern. Unlike nuclear weapons, biological weapons (B-bombs) are more readily produced, easily hidden in stable dormant states, and present clear and present danger to human populations through a variety of lethal and maiming modalities. Accurate, precise and timely annunciation of BCNWMD agents is of utmost importance for insuring and preserving the health, safety and well being of human and other populations. People living in modern cities and "edge cities" and mass transportation systems are

particularly vulnerable to attacks using such agents. To defend against such agents, suitable sensors, acting like the mineshaft canaries of history, are needed for a variety of missions. To minimize the threat of BCWMD and EID to human populations, and to assist in the elimination of these threats, there is a need for a biosensor capable of responding to-, classifying, and annunciating chemical, biological, nuclear and metabolic threats from known and unknown organisms or other agents to biological processes within one second, *i.e.*, rapidly, accurately and with precision.

This sensor can respond to biological (B), chemical (C), drugs and their precursors (D) and nuclear (N) threats, sic. a BCDN biosensor. This sensor is a new cell-based technology, based on a newly discovered sentinel cell, is being developed. This new technology is called the "Trained Cell" (patents issued and pending). Trained Cells are tuned to respond, in a characteristic fashion, to particular ligands or other reactants, especially those that disrupt normal metabolic processes. The modeling framework being developed for Trained Cell incorporates a full suite of attributes for each agent and their targeted and affected systems and processes – from data and metadata – acting within a spatial-temporal framework that can be dynamically assessed to faithfully represent biological, meteorological and epidemiological attributes – and the clinical presentations, anticipated morbidity and lethality potential.

This system, that non-technical personnel can operate, can classify responses based on the genus/species/strain and degrees of molecular homology. The system will provide forensics support through the collection of the detected agent. This approach is compatible with current systems and investments both horizontally (*e.g.,* in concert with other detection modalities) and vertically (*e.g.*, communications, decision and logistics). We believe that the approach will provide a new and important means of annunciating WMD and pathogens in air and water, for point-of-interest and wide-area surveillance, military operations, protection of public sites and embassies, and other situations in domestic and foreign locations and of offering timely notification and treatment of affected individuals; evaluation and response by the Chain of Command (*i.e.*, public health, military); and, development of new countermeasures. Biological agents used as offensive weapons in conventional, unconventional and terroristic warfare – and those (re)emerging despite previous public health control efforts – know no boundaries, nationalities, political or religious preferences, *et cetera* – they are equal opportunity threats to which we are all vulnerable; we must be prepared.

The False Contact Environment in Littoral Waters

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In future conflicts, forward Naval power will be required for battle-space preparation and timely crisis response against anti-access and area-denial forces in littoral waters. These waters are often crowded with air, surface, and sub-surface objects that can lead to false contacts in all sensor systems. False contacts can severely degrade the performance and effectiveness of military search, localization, and prosecution systems. For example, reactive forces may be employed, and weapons expended, unnecessarily and detection and prosecution of real targets can be delayed or missed. The false contact problem can be asymmetric in that it helps real targets hide but it hinders searchers. Further compounding the problem is that threat signatures, sensors, and weapons are improving.

After examining the general false contact problem, this paper explores the nature of false contacts in the littoral anti-submarine warfare (ASW) environment. Operations research models, data, and results are discussed which: (1) demonstrate how false contacts can deleteriously affect system performance and effectiveness and (2) can be used to derive tactical and technological methods for the operational improvement of ASW.

The False Contact Environment in Littoral Waters

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The following abstracts are listed in alphabetical order by principal author.

Trends for Objective Force Concept Development

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This presentation presents the findings of a review of selected studies and analyses of potential future force concepts that have been used by the U.S. Army Training and Doctrine Command (TRADOC) in the early development of Objective Force concepts. The report derives important and consistent trends from the source studies, and establishes a linkage between these trends and elements of the current Objective Force Operational and Organizational (O&O) Concept, Joint Vision 2020 and the Army Vision. This effort supports further development of the Objective Force O&O Concept by establishing a basis for core concepts and characteristics.

Search & Destroy ... then Rebuild Quickly!

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"Becoming more efficient is the third major challenge confronting America's Army. By becoming efficient, the Army intends to garner savings to help ensure it can maintain a force structure commensurate with operational commitments... By taking advantage of technological advances, streamlining our processes, and reorganizing our institutions the Army can gain significant savings and improve effectiveness and efficiency..." - Secretary of the Army from his Statement to Congress on the Posture of the United States Army for FY97 (Chapter 4)

The Army's commitment to achieving efficiency during peacetime by exploring (and using) technical innovation may now have a wartime spin-off advantage as America engages a world-wide war against terror for an undetermined period of time. Usually the opposite is true, wartime pressures on industry to develop more lethal war components tend to generate post-war improvements for society in general. Now that the great war against terror is on, a sounder, more efficient procedure needs to be considered for post-combat reconstruction as a means to maintain the momentum in counter-terrorist operations. In this war its not enough to kill the enemy quickly through instant and overwhelming means only to be haunted later by collateral devastation to an innocent general population. This mistake invites a resurgence of sympathy for the defeated regime or at a minimum sharpens an excuse for hatred against America which other foreign enemies are only too happy to contrive.

How to blunt this possibility by devising a rapid deployment for reconstruction will be the theme of this paper.

This paper is about an aspect of military thinking that needs up-dating, a modification to the notion that complete enemy devastation will guarantee the destruction of terrorism. In some instances this paper will offer revolutionary, bold, new and creative vision that pushes the envelope on achieving results through the rapid application of innovation. Then suggest making it a part of the standard military operation against terrorists. American ingenuity is the most valuable intellectual asset our Country possesses, yet its management (at times) has been allowed to stagnate.

The paper has two parts: first, a discussion on two example innovations and their economic possibility for the peace-time Army; the second part of the paper is about the transitioning of these examples to a meaningful and immediate, post-combat application using the war in Afghanistan as an example.

Land C2 in a Supply and Transportation Constrained Environment in JWARS

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The JWARS Land forces are represented at a level of detail and a breadth that has not been attempted before in long running, Theater-level models. This has meant a much larger number of ground units to command and control over a much longer time period and, consequently, more concerns to be addressed than in past theater models. This presentation focuses on the Land Commander and Supply Planner represented in JWARS and describes the symbiotic relationship that exists between them. The Supply Planner (G4) basis his requests on his subordinate's current needs and the expected operations described in the Land Plan, while the Land Commander's plan is, itself, constrained by the ability of the supply and transportation system to provide the needed Classes of supply. Specifically, the presentation addresses the JWARS:

Commander's Model (Situation Assessment, Course of Action (COA) Selection, and Guidance)
The role of supply in the Commander's Wargame
The Transportation and Logistics system (TPFDD integration and intra-Theater resupply)
Land Supply Planner (supply projection, local resupply, and local transportation)
Prioritization of supplies on a perception based battlefield

Particular emphasis will be placed on the difficulties of projecting operations and transporting supplies in a two-sided engagement, where each force recognizes that running out of munitions or fuel by either side equals its defeat and takes that into consideration when building his war plan. This presentation provides sanitized examples of COA selection by the Commander's Wargame algorithm, demonstrates the impact of supply consumption and resupply capability on that selection, and shows the discrepancies that can occur between the plan and the running of the simulation itself.

Objective Force Concept Exploration, A Notional Combat Battalion Engagement

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This study supports Objective Force Combat Battalion concept development and the Army Transformation. It focused on developing, examining, and refining Combat Battalion concepts, and supporting the Future Combat System (FCS) Mission Needs Analysis.

The study scenario facilitates analysis of the Objective Force in combat operations. The scenario provides a context in which an Objective Force Combat Battalion conducts offensive operations in 2015 against a technologically advanced Red force. The engagement was explicitly modeled using the Interactive Distributed Engineering Evaluation and Analysis Simulation (IDEEAS) model. IDEEAS is an entity-based simulation, capable of force-on-force representations, that permits examination of concepts and parametric analysis at the engineering level of detail. Use of the notional battalion force structure allowed O&O concept exploration prior to force design decisions.

This study contributed substantially to the development of the Objective Force, especially with regard to the Unit of Action force design. In addition to the development of concepts, tactics, and insights for future operations the study provided a powerful visualization of this future force. The scenario and base case developed during this study were used extensively by the TRADOC Unit of Action Task Force in their subsequent refinement of the force design. These tools were also used by the Army Medical Department in its transformation wargame effort.

This presentation will provide an overview of the study scenario's purpose, methodology and results.

Wargaming to Support Objective Force Concept Development

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The Objective Force is the realization of the Army vision that was presented by the Chief of Staff of the Army (CSA) in October 1999. The transformation from vision to fielded Objective Force is a process that will occur over several decades. An early and critically important piece of this process is the development of Operational and Organizational (O&O) Concepts. These Objective Force O&O concepts are grounded in the futures work that was done as part of the Army After

Next (AAN) project. Futures wargaming has evolved to become an important part in the development of these concepts. In particular, the annual Army Transformation Wargame (ATWG) has emerged as the Army's most visible event for future concept development.

The TRADOC Analysis Center (TRAC) serves as the lead analytic agency for the ATWG sponsored by the TRADOC Deputy Chief of Staff for Doctrine (DCSDOC). This series of wargames is designed to describe, refine and evaluate Objective Force concepts and capabilities over a multi-year period. These wargames provide the Army an opportunity to explore future Army operations at the strategic and operational levels of war in a political/military wargame environment.

This presentation will address the analytic support provided to ATWG 01, *Vigilant Warriors*. In particular, it will provide an overview of the wargame to include analysis and reporting of the insights for the issues addressed.

Common Missile Range Requirements Analysis

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Current TOW and Hellfire missile families will not adequately address emerging threats/capabilities of advanced armor protection, active protective systems (APS), and defensive aid suites nor provide sufficient standoff to counter the increased range of emerging threat air defense and anti-tank guided missiles. The US Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC) performed the Common Missile Range Requirements Analysis as part of an overall analytic effort supporting acquisition of the Common Missile (CM). This range requirements study develops additional analytical rationale for Key Performance Parameters (KPP) published in the draft CM Operational Requirements Document (ORD). This study evaluates the impact of CM range on the operational effectiveness of Army and Marine Corps ground and aviation forces at the Corps and Division level. This study compared two missile range alternatives (both 12-km and 16-km ground and aviation missiles) against a base case using current TOW and Longbow Hellfire missile ranges. Study methodology included combat simulation of the base case and alternative force capabilities, in the context of two major theater war scenarios, using the Vector-In-Commander (VIC) model.

TRACER/FSCS Combined Analysis

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During the last two years, a combined UK/US operational analysis working group conducted the Tactical Reconnaissance Armoured Combat Equipment Requirement (TRACER)/Future Scout Cavalry System (FSCS) analysis leading up to the February 2001 Affordability Review held in London. This presentation will show the study approach, highlight the initiatives in new Measures of Performance (MOP) and Measures of Effectiveness (MOE) used by the two countries, note the challenges and successes of a combined analysis and present the analysis results. Included in the presentation will be:

- A brief review of the methods and tools used in the analysis, including the MOE and MOP, the models, and scenarios,
- The technical analysis and system performance approach and results.
- The operational effectiveness analysis results, highlighting the effects of innovative approaches to representing ground scout capabilities in combat models, and the insights gained from the work.
- The combined cost analysis approach and results.
- General conclusions and recommendations.
- Lessons learned regarding MOE and MOP that may apply to Future Combat System and Objective Force analysis.

Interim Division Design Analysis: Lessons Learned for Objective Force Analysis

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This paper focuses on the lessons learned from Interim Division Design Analysis and how they relate to upcoming Objective Force analyses. In February 2000, the U.S. Army Training and Doctrine Command (TRADOC) began investigating various appropriate parent organizations in which to place the five to eight Interim Brigade Combat Teams (IBCT) that the Army envisioned fielding as part of Army Transformation. Over the past two years, the ideas and concepts that TRADOC explored led to a division structure that was built on three IBCT-like organizations. This division formed the basis of TRADOC's IDIV development effort. The concepts were investigated using a variety of analytic tools and included a comparison of the IDIV's deployability, sustainability, lethality, survivability, agility, versatility, and overall strategic responsiveness to that of a Limited Conversion Division with an embedded IBCT and a Light Infantry Division.

The Interim Division Design Analysis required innovative thinking and development of new methodologies to address interim force design issues. This paper will address the methodologies developed and how they relate to the Objective Force analyses.

Common Missile Requirements Analysis

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In response to a U.S. Army Headquarters, Training and Doctrine Command (TRADOC) tasking, the TRADOC Analysis Center at Fort Leavenworth (TRAC-FLVN) led an analysis of Common Missile requirements. The purpose of this study was to underpin development of the Common Missile Operational Requirements Document, help guide contractor efforts to develop Common Missile design alternatives, and help identify areas for further investigation in a subsequent Analysis of Alternatives.

The objective of the Common Missile acquisition program is to field a single missile to replace the TOW and Hellfire missile families and possibly, to field a missile variant for fixed wing platforms.

Primary study team organizations included TRAC-FLVN, TRAC-White Sands Missile Range, TRAC-Fort Lee, Program Executive Office-Tactical Missiles, and the Threat Support Directorate in the Headquarters TRADOC Deputy Chief of Staff for Intelligence. Important supporting contributions came from the following U.S. Army organizations: Army Materiel Systems Analysis Activity, Aviation and Missile Research, Development, and Engineering Center, TRADOC Systems Manager (TSM)-Longbow Apache, TSM-Comanche, TSM-Close Support Missile Systems, and the Infantry, Aviation, and Armor Schools.

The paper provides an overview of the analysis methodology used, scenarios employed, and study alternatives. It also presents important findings and conclusions regarding required missile range, lethality, and "fire and forget" and "man-in-the-loop" missile engagement modes.

Objective Force Risk Analysis

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In the early 1990's the Army set the goal of applying risk management principles to all of its projects and processes. TRAC has begun a risk management analysis of the Army's transition to the future Objective Force. This analysis supports the development of Objective Force concepts by identifying the hazards most dangerous to future operations and most relevant to the transition process.

The presentation will cover, in addition to the results, the challenges of identifying the hazards, collecting the data (via a survey), and analyzing the data.

Historical Analysis of SSC Operations

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CAA performed the initial work, called the Stochastic Analysis of Resources for Deployments and Excursions (SARDE), under the sponsorship of the War Plans Division of the Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS). SARDE's objectives include the development and demonstration of a methodology to predict the requirement for Army units, by type, needed to support simultaneous smaller scale contingency operations (SSCs) in the future. In October 2000, the Operations Directorate of ODCSOPS requested an update using historical data to the greatest extent possible. The work also needed to use any updates to the methodology. This study, called Historical Analysis of SSC Operations 2000 (HASO 2000), was completed in 2000, revised and updated in 2001, and provided to staff agencies in ODCSOPS for use in their overall force structure requirements analysis.

Information Exchange Requirements (IERs) Development in Support of the Army Transformation

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The Applied Physics Laboratory of Johns Hopkins University (APL), in support of Army Transformation, conducted a "Future Combat Systems (FCS) Network-Centric Concepts and Operations" study. The purpose of the study is to develop a candidate architecture that facilitates network-centric operations. This two phase study was sponsored by the Office of the Deputy Assistant Secretary for Research and Technology, Assistant Secretary of the Army for Acquisition, Logistics, and Technology [ASA(ALT)].

Phase I developed a qualitative identification of candidate FCS force network architectures and their associated primary tasks and information exchange requirements (IER). Phase II consisted of detailed technical assessments of candidate architectures to quantify network requirements and propose a recommended architecture that enables FCS network-centric operations at force level echelons. The development of an Objective Force (OF) environment and IERs was a key step in the study process. The development of the Objective Force environment was conditioned by an emerging set of Objective Force Operations and Organizational Concepts (O&O), FCS acquisition documents, and ongoing FCS studies and experiments. The study methodology is characterized by its flexibility and adaptability to a maturing O&O. The IERs were developed within the context of the OF environment and represent a class of tasks, message content, and network capacity requirements that are sufficiently detailed so as to support the development of traffic modeling across a set of candidate network architectures.

This presentation will describe the development of an Objective Force environment, its associated information exchange requirements, the implications of traffic modeling, and the development of a candidate network architecture that enables network-centric operations.

Global War on Terrorism (GWOT) Special Project (SP)

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The Global War on Terrorism (GWOT) has taken center stage in much of the joint planning on higher staffs and many of our minds. The presentation focuses on one specific operation. This operation centers on modifying a current scenario with limited objectives and a constrained available force. The purpose is to evaluate varying cases in a joint environment on the basis of achieving the objectives and the risk associated with each case.

Collateral Damage Study

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The U.S. Army Materiel Systems Analysis Activity (AMSAA) developed a Collateral Damage Study Plan to support both the XM982 Excalibur and Precision Guided Mortar Munition (PGMM) Analyses of Alternatives (AoA's), as well as to provide the Army with a current assessment of collateral damage potential for current an emerging munitions.

The purpose of the Collateral Damage Study is to compare the effectiveness and collateral damage potential for a variety of indirect munitions versus tactical targets in urbanized areas. The measures of collateral damage will include damage to buildings, civilian vehicles and civilians on the streets. The three measures will be integrated to a single measure of collateral damage relative to civilians receiving a serious wound to facilitate comparisons between the munitions.

To conduct the Collateral Damage Study, seven terrain templates have been developed to represent typical urbanized areas that one might find globally. These templates were based largely on the in-depth work of Dr. Richard Ellefsen. For the study, each target will be placed in particular locations on one of the urban templates. The damage to the tactical targets, civilian vehicles, and to civilians on the streets will be measured using standard AMSAA Effectiveness models; i.e. Simplified Artillery Projectile Effectiveness Model (ARTQUIK), and Support Warfare Mean Area of Effects (SWAMAE) model. The ARTQUIK model calculates the effects of conventional artillery firing high explosives or improved conventional munitions against homogeneous targets. The SWAMAE model generates the component-level and whole-vehicle mean area of effects which are used in effectiveness programs such as ARTQUIK. Additionally, the Modular Effectiveness Vulnerability Assessments (MEVA) Military Operations in Urban Terrain (MOUT) model, will be used to evaluate the damage to buildings.

C3 Test Driver Scenario Development

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The Command, Control, and Communications Test Driver program was initiated in response to a Deputy Undersecretary of the Army for Operations Research (DUSA-OR) tasking. The US Army Test and Evaluation Command (ATEC), the US Army Simulation, Training and Instrumentation Command (STRICOM), and the US Army Electronic Proving Ground (EPG) lead the C3 Test Driver Program. The Program involves key participants within the TRADOC Analysis Center (TRAC), the Central Technical Support Facility (CTSF), the US Army Operational Test Command (OTC), and the TRADOC Threat Support Directorate (TSD).

The objective is to support developmental, integration, and operational testing of Army Battle Command System (ABCS) components using standard models, standard mission/message threads, and standard scenarios.

The scenario development effort was tasked in Phase I of the C3 Test Driver Program (FY01) to produce an unclassified, brigade-level scenario to be used as the background for C3 Test Driver message generation and traffic. This scenario was located on the National Training Center and featured a Force XXI brigade against an opposing gorces division. Key events were identified within a scripted time-ordered event-list to initiate various mission/message threads. C3 Test Driver uses this message traffic to stimulate real systems under test, evaluate their performance, and facilitate developmental and integration testing.

Classified corps-division and brigade-level scenarios are being developed for use in Phases II and III of this program. These scenarios, and vignettes identified within them, will use a dynamic simulation and a robust set of doctrinal mission/message threads to additionally support operational testing and training.

Littoral Warfare and Regional Sea Control WG-13

Chair: Terry McKearney, McKearney Consulting
Gordon Hall, Coastal Systems Station, Panama City, FL
John M. Green, Naval Postgraduate School
Advisor: Jerry Kotchka, Lockheed Martin, Naval Electronics and Surveillance Systems
GIF 352C

The following abstracts are listed in alphabetical order by principal author.

JWARS: Littoral Warfare

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The Joint Warfare System (JWARS) will be a state-of-the-art, constructive simulation that shall provide a multi-sided and balanced representation of joint theater warfare. Users of JWARS will include the CINCs, Joint Task Force (JTF) Commanders/Staff, Services, Joint Staff, Office of the Secretary of Defense (OSD), and other DoD organizations. JWARS will be capable of performing Courses of Action and Force Sufficiency analyses at IOC, and will be able to perform System Effectiveness and Trade-off analysis and Concept and Doctrine Development at FOC.

This presentation will provide insight into the Maritime warfighting functionality that has been designed into the JWARS simulation to date. Discussion will center around Maritime C4ISR, Surface Warfare, Mine Warfare, Naval Surface Fire Support, Undersea Warfare, Undersea Warfare, Naval Blockade, Aegis TBMD and Forcible Entry (Amphibious Warfare). A Screen Cam image of the simulation will be available at MORSS and will provide a point of discussion where appropriate. The Joint Analytic Model Improvement Program (JAMIP) is the proponent of the JWARS model. The associated JAMIP Executive Committee (EXCOM) and Steering Committee (SC) are the associated approval authorities for the JWARS program. This presentation will discuss the importance of Joint warfare and its relationship to Maritime capabilities along with JAMIP oversight to the program.

Strategic Anti-Missile Attrition Zone (SAAZ) Defense

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The paper presented in this presentation will do away with conventional thinking and structure a practical approach to the quagmire of uncertainties associated with a national missile defense. It will key into the Defense Secretary's desire to explore new approaches, think beyond the conventional, and attempt "out-of-the-box" vision. It will advance a notion of shared cost-shared responsibility among all the Armed Services making use of all the good and valuable work heretofore accomplished by an unprecedented Government/Contractor effort. The paper is an attempt to kick-start thinking and provoke questions in response tot he Secretary's 2 January "guidance" memorandum that clearly challenges us all to revitalize our thinking.

The paper concludes with a hypothetical war scenario taking place in the year 2025, which call into play a smooth working relationship of all the Service including the US Coast Guard.

Search Theory, Invented Now

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Search Theory was developed when operators and academics collaborated to apply mathematics to a very tangible task: to find a militarily important object in the quickest, best way possible. Early Search Theory successes contributed to the foundations of a new discipline, Operations Research. This field now consists of two types of professionals, analysts who work directly with operators to solve pressing operational problems and academics who work to develop new mathematical

results. Within the topic of Search Theory, however, these two groups have increasingly diverged since their early practical successes. While the Operations Research Analysts continue to ply their trade with a toolbox of practical techniques among tactically minded decision makers, the academics have gravitated to interesting but extraordinarily abstract results in complex multivariate mathematics. A major research topic of much recent work in operations research has been the development of effective search algorithms for finding good solutions to very complex optimization problems.

A third claimant to search solutions is now emerging: almost every advanced warfare concept depends on high-performance collective robotics, most notably for search and surveillance operations. This raises an intriguing proposition: might arranging the instruments of a search (collective autonomous agents) require the same complex optimization solutions as the process of the search (finding the target)? If so, we are on the verge of a new, ironic definition of Search Theory. More importantly, it appears that the fundamental precepts of Koopman-style Search Theory might warrant reconsideration. This presentation reports on a recent workshop in which the conferees discussed the question, "What would Search Theory look like if it were invented now?"

Major Theater War – Western Pacific (MTW WestPAC) Joint Campaign Analysis

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This presentation will introduce a new planning scenario and joint campaign analysis for a major conflict in the Western Pacific (MTW WestPAC). This scenario postulates the naval blockade of a nation friendly to the United States and explores the options available for a joint response. The MTW-WestPAC scenario was originally developed by OPNAV N81 and has since been used in the Quadrennial Defense Review and the Navy planning process. This presentation will include an overview of the scenario including the major options for joint operations in response to the threat, an overview of the analytic approach taken and tools used to develop the assessment baseline for the scenario, and a summary of the assessment baseline results and excursion analyses identified.

System-level Analysis of Sea-based Missile Defense Using High Fidelity Monte Carlo Simulation

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Approved abstract unavailable at printing.

Defending the Sea Lance

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As the Navy transforms itself into a littoral fighting force it is becoming clearer that a centerpiece of the change may be a new class of smaller, stealthier, and faster ships. These "Streetfighters" will be characterized by small crews, smaller sensors, and an operational mandate to operate much closer inshore of the dangerous waters of our nation's foes. These smaller platforms will be at greater risk because of their postulated sensor-weapons mix. For example, the High Speed Vessel (HSV) would be equipped with CEC and Sea Ram. This limited capability gives rise to the concern that lessons learned such as the USS Stark may be receding into the dim past.

This paper asserts that the layered defense concept applies at the ship or node level as well as the Battle Force level. These platforms may be required to operate at the edge of the defensive umbrella. The defensive capabilities of these smaller ships must be able to address the shortened engagement timelines created by proximity to land. The most viable approach to self-defense is a layering of active and passive weapons assets focused on disrupting the threat kill chain. In addition, the small crews envisioned require an innovative approach to how these weapons will be served. The paper will summarize the key issues in developing a layered defense at the platform level and present a notional concept for defending the Sea Lance.

Littoral Warfare and Regional Sea Control WG-13

Layered Defense and Interoperability within the Navy

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A crucial issue to the success of an AAW layered defense is communications between and within the layers. The Navy is faced with a dilemma in developing a satisfactory AAW layered defense because combat system development has followed two divergent paths, AEGIS and SSDS MK2, resulting in significant interoperability problems. Despite both the ATHENA and the more recent Common Command and Decision efforts the Navy has not developed a paradigm that merges the concepts of area defense and self-defense. Both AEGIS and SSDS MK2 continue development within their own stovepipes.

This paper contends that an effective layered defense should be pursued from the perspective that solutions to interoperability issues between and within platforms can be developed from a common architecture that supports network centric warfare. In support of this point of view, the paper discusses a high level architecture that is derived from relevant sources such as Operational Requirements Documents (ORDs) that address layered defense and interoperability at the battle force and platform (or node) level. The AEGIS and SSDS MK2 system functions are mapped against this top-level architecture and their contributions to layered defense are compared. The identified similarities and differences are contrasted and a roadmap to a merger of both systems is presented.

Combined Forces Command Amphibious Analysis III

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The Combined Forces Command Amphibious Analysis III analyzes a branch plan of a Combined Forces Command Operation Plan (OPLAN) employing combined Naval and Marine Forces. For this analysis, TRAC employed its own Vector in Commander amphibious modeling capabilities. TRAC also integrated analytical efforts from a number of joint service agencies such as US Transportation Command's Military Traffic Management Command Transportation Engineering Agency, the Center for Naval Analysis, Marine Corps Combat Development Command, and the Navy's Mine Countermeasures Squadron One to complete the effort. The presentation will highlight the amphibious operations modeling approach, the study methodology, study findings, and analytical insights.

Naval Network-Centric Sensor Resource Management

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The benefits of implementing a network-centric Navy lie in the new capabilities made possible by enhanced information sharing between Naval platforms. Foremost is the potential to enable, enhance, and automate dispersed decision-making to support real-time critical mission areas. This paper explores a network-centric paradigm-enabled application: multi-platform sensor resource management.

Sensors in platform-centric Naval Battle Forces are generally utilized and managed to support a single weapon or combat system. The networking of combat systems and platforms creates an information architecture in which sensor management can shift to a Battle Force (BF) focus. In such a network-centric paradigm, individual sensors address the needs of the BF as a whole, overcoming the platform-centric architecture, which constrains sensor use to individual platform's needs. Such BF level thinking shifts the focus from legacy stovepipe systems and platforms with little or no collaboration incentive, to optimized uses of resources that transcend platform boundaries and span multi-threat dimensions. This paper explores interoperability problems and root causes associated with legacy Naval BF sensor management and poses solutions and considerations for a network-centric sensor resource manager that functions as part of a BF system of systems

Network-centric sensor resource management relies on viewing the BF as a single integrated interoperable combat system of systems, rather than a collection of loosely connected surface, subsurface, and air platforms. Information concerning the tactical battle space and BF resources (status & capabilities of sensors, weapons, communications, etc.) must

be timely, accurate, and consistent across the BF in order to enable optimized sensor command and control. This paper contrasts various BF command and control architectures and infostructures (information architectures) based on their ability to best support sensor resource management for BF needs. In addition the paper addresses information requirements necessary to support the network-centric sensor resource manager and explores decision-making techniques, human-machine interactions, and levels of automation for a network-centric sensor resource manager

Problems Plaguing the Network Centric Paradigm

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In order to implement Joint Vision 2010, a network centric paradigm is required in which layers of defense systems (differing in geographical separation, technical function, operational employment, and Service affiliation) interoperate and function collectively as a system of systems. Key to this cooperation is timely and accurate information and knowledge sharing with a goal of achieving information superiority. This information interoperability forms the fundamental basis for achieving precision engagement and time critical targeting, ultimately necessary for attaining the "Joint Vision" – gaining full spectrum dominance. Emerging from the set of plaguing problems are architectural features and patterns that formulate a network centric solution. An example of the solution set is the convergence of the various "information loops" (i.e., the JPN, JDN, and JCTN) that are currently separated according to their inherent time domains (non-real-time, near-real-time, and real-time). Information synchronization between time domains is as critical as synchronization across geographically separated platforms. The emerging solution set is used in the synthesis of a logical architecture necessary for converting the network centric paradigm from a "Joint Vision" into a "Joint Reality."

This paper discusses root causes of interoperability problems that plague the network centric paradigm. Naval systems are used as an analysis starting point and then extended to the Joint realm. The analysis assumes a network centric warfare perspective in which the Naval Battle Force (BF) is viewed as the network comprised of platforms (i.e., ships, submarines, and aircraft) as nodes within the network. In order to extend the analysis to the Joint realm, the Naval BF becomes treated as a node within an integrated network of multi-Service forces. This network centric vision requires a layered defense of individual nodes capable of operating independently yet seamlessly integrating into a coordinated network.

Surface Ship Signature Cost-Effectiveness

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Many studies have attempted to quantify the benefits of signature control for surface ships. Far fewer studies have quantified the costs. Now, as the Navy considers ships designed especially for littoral operations, the situation becomes even less clear. In these cases, the benefits are not well established, and costs are not addressed. In this study, we will enhance the understanding of the benefits for these future ships and gain a clearer understanding of the costs across a wide spectrum of ships. We will especially address the impact of evolving threat technology on these benefits and costs. The study is beginning in March 2002. The presentation will outline the current understanding, describe the process, and provide any emerging results..

UH-60A, SH-60B, SH-60F, HH-60J, MH-60K, UH-60L, CH-60S: Are They All the Same?

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In response to the terrorism of 11 Sep 01, Operation Enduring Freedom is underway. Much of our nation's military might is involved—Air Force bombers, Navy ships, Marine Corp troops, and Army Special Operations. How will they work together to project power deep into enemy territory? This question has our military reviewing the requirements for joint

shipboard/helicopter interoperability. As Operation Enduring Freedom has already proven, the US Army and Air Force must be prepared for joint operations. The Office of the Secretary of Defense (OSD) chartered the Joint Shipboard Helicopter Integration Process (JSHIP) Joint Test and Evaluation (JT&E) program back in 1998 to answer such issues.

The backbone of interservice rotorcraft aviation is Sikorsky's H-60—the Army has over 1500 of these airframes, the Air Force has just over 100, and the Navy looks to transition to an all-H-60 helicopter fleet. JSHIP has taken on the unique challenge of conducting an H-60 similarity study. Currently, H-60 similarity research is being duplicated by the services and/or tends to be service-derived independently. This study provides answers in most aspects where H-60s have traditionally been perceived as being equal. Taking unbalanced historical data, this study proceeded to analyze the low airspeed flight characteristics of seven different H-60 models. The primary analytical technique was Exploratory Data Analysis (EDA). The results from this analytical method, though not statistically comprehensive, will be used in support of standardization of shipboard launch/recovery envelope development for Navy, Army, and Air Force H-60 variants. This presentation will center on the basic conclusions from the historical data and a challenge to continue to refine flight test analytical procedures.

Crossbow Project

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"Crossbow" is a year-long project by about 10 professors and 40 students at NPS. The aim was to explore the potential of a 10,000 ton UCAV/UAV carrier as a force component in littoral operations. The design complements small "streetfighters" and high speed amphibious ships. Crossbow comprises 45-50 knot formations, tailored to task, for independent operations inshore. It can also supplement a Blue Water naval force in a MTW or other large scale operation, acting as its advance, distributed component. Crossbow was tested in five scenarios. A notional force is 8 "Sea Archers," each carrying 8 15,000 lb "Sea Arrow" UCAVs, 8 lighter UAV scouts, and 2 H-60 type helicopters; 20 "Sea Lance" 600 ton surface combatants; and 2-4 "Sea Quiver" CLF ships.

This presentation will provide a summary of the "Crossbow" project, including a video describing and chronicling the students' work.

An Analysis of Engagement Coordination Methodologies of Aegis Platforms

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As both communications bandwidth increases and computing capability continues to become more sophisticated, the ability to share information and resource states across platforms in real time becomes more realizable. Thus, the potential for a complete realization of the vision of Network Centric Warfare comes closer to reality. With these advances and the constantly evolving, more dangerous threats, the need for multi-platform Distributed Weapon Control (DWC) becomes inevitable. DWC consists of three components, namely, Threat Assessment, Sensor Coordination and Engagement Coordination. Engagement Coordination is the utilization of forces, networked information and resources in a more effective way to defeat the enemy and is the topic of interest in this brief.

The High Performance Distributed Computing (HiPer-D) laboratory is a real-time laboratory located in Dahlgren Virginia where multiple Aegis tactical system platforms are prototyped in order to demonstrate proofs of concepts with respect to advanced computing architecture and algorithm development. There it was shown that a multi-objective algorithm could make a decision in a tactical environment in real-time by sharing fire control information across Aegis platforms. The next phase was to show value added to the battle group. This brief describes the current Engagement Coordination schemes in the Navy Fleet today. It then demonstrates through modeling how using shared high fidelity fire control information, platform state information across platforms and a multi-objective decision algorithm can improve battle group effectiveness. The focus of this brief is to show the value added using a multi-objective decision algorithm to select the shooter over the current Engagement Coordination schemes used in the Navy fleet today. Additional discussion includes how this methodology can be extended to other, non-Aegis platforms due to the generic criteria and required interfaces.

Chair: Trena C. Lilly, Johns Hopkins University Applied Physics Laboratory
Co-chairs: Timothy Sullivan, Lockheed Martin
Michael Truelove, Innovative Emergency Management, Inc. (IEM)
Advisor: FT Case, JHUAPL
GIF 178
Session 5, Wednesday, 1330-1500, GIF 357C

The following abstracts are listed in alphabetical order by principal author.

JWARS: Littoral Warfare

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The Joint Warfare System (JWARS) will be a state-of-the-art, constructive simulation that shall provide a multi-sided and balanced representation of joint theater warfare. Users of JWARS will include the CINCs, Joint Task Force (JTF) Commanders/Staff, Services, Joint Staff, Office of the Secretary of Defense (OSD), and other DoD organizations. JWARS will be capable of performing Courses of Action and Force Sufficiency analyses at IOC, and will be able to perform System Effectiveness and Trade-off analysis and Concept and Doctrine Development at FOC.

This presentation will provide insight into the Maritime warfighting functionality that has been designed into the JWARS simulation to date. Discussion will center around Maritime C4ISR, Surface Warfare, Mine Warfare, Naval Surface Fire Support, Undersea Warfare, Undersea Warfare, Naval Blockade, Aegis TBMD and Forcible Entry (Amphibious Warfare). A Screen Cam image of the simulation will be available at MORSS and will provide a point of discussion where appropriate. The Joint Analytic Model Improvement Program (JAMIP) is the proponent of the JWARS model. The associated JAMIP Executive Committee (EXCOM) and Steering Committee (SC) are the associated approval authorities for the JWARS program. This presentation will discuss the importance of Joint warfare and its relationship to Maritime capabilities along with JAMIP oversight to the program.

Trends for Objective Force Concept Development

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This presentation presents the findings of a review of selected studies and analyses of potential future force concepts that have been used by the U.S. Army Training and Doctrine Command (TRADOC) in the early development of Objective Force concepts. The report derives important and consistent trends from the source studies, and establishes a linkage between these trends and elements of the current Objective Force Operational and Organizational (O&O) Concept, Joint Vision 2020 and the Army Vision. This effort supports further development of the Objective Force O&O Concept by establishing a basis for core concepts and characteristics.

Search & Destroy ... then Rebuild Quickly!

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" Becoming more efficient is the third major challenge confronting America's Army. By becoming efficient, the Army intends to garner savings to help ensure it can maintain a force structure commensurate with operational commitments... By taking advantage of technological advances, streamlining our processes, and reorganizing our institutions the Army can gain significant savings and improve effectiveness and efficiency..." -Secretary of the Army from his Statement to Congress on the Posture of the United States Army for FY97 (Chapter 4).

The Army's commitment to achieving efficiency during peacetime by exploring (and using) technical innovation may

now have a wartime spin-off advantage as America engages a world-wide war against terror for an undetermined period of time. Usually the opposite is true, wartime pressures on industry to develop more lethal war components tend to generate post-war improvements for society in general. Now that the great war against terror is on, a sounder, more efficient procedure needs to be considered for post-combat reconstruction as a means to maintain the momentum in counter-terrorist operations. In this war its not enough to kill the enemy quickly through instant and overwhelming means only to be haunted later by collateral devastation to an innocent general population. This mistake invites a resurgence of sympathy for the defeated regime or at a minimum sharpens an excuse for hatred against America which other foreign enemies are only too happy to contrive. How to foil this possibility by better utilizing America's strategic power to rebuild as an extension of its combat power: it is about rapid development as the flip side of rapid deployment. It is about blunting the enemy's favorite counterattack: the inspiring of hatred by equating America to a victim's misery and hopelessness. The paper will touch on an aspect of military thinking that needs rejuvenation, an adjustment to the notion that complete devastation will guarantee the destruction of the physical enemy when the true enemy is always hunger, poverty, desperation, and chaos - the new Four Horseman - ushering in an age of terror.

This paper is about an aspect of military thinking that needs up-dating, a modification to the notion that complete enemy devastation will guarantee the destruction of terrorism. In some instances this paper will offer revolutionary, bold, new and creative vision that pushes the envelope on achieving results through the rapid application of innovation. Then suggest making it a part of the standard military operation against terrorists. American ingenuity is the most valuable intellectual asset our Country possesses, yet its management (at times) has been allowed to stagnate.

Decision Superiority: What It Is, Why It Is Important, and How We Can Do It Better

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Last year the Institute for Defense Analyses sponsored a Workshop on Decision Superiority. Fundamental to the precepts of Joint Vision 2020, Decision Superiority is defined as "better decisions arrived at and implemented faster than an opponent can react...at a tempo that allows the force to shape the situation or react to changes to accomplish its mission." The purpose of the Workshop was to gain an improved understanding of the enabling elements of Decision Superiority and to describe how to organize, deliver, and use information to achieve this capability. The Workshop provided an opportunity for experts in training, information technologies, command and control organizations and doctrine, and behavioral science, as well as senior military personnel, to focus critical thinking on this important topic. Ultimately, we plan to define metrics that describe our ability to achieve Decision Superiority. This briefing will carefully define what is met by decision superiority and will discuss 8 recommendations emanating from the workshop on actions the U.S. can take to achieve it.

Design Principles of Distributed Naval Forces

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Defense community innovators have proposed concepts that use cutting-edge technologies to solve long standing military challenges, including destruction of time-critical targets, theater-wide surveillance and power projection and access to contested littorals. These concepts assume great benefit from networking of unmanned, distributed force, but a useful definition of networked forces does not yet exist and the advantages of networking have not been fully and convincingly expressed. This document defines and describes how "Distributed Forces" provide Information Age advantage and offers some design principles for future distributed naval forces.

Campaign Analysis / Decision Support System for Unified and Component Commanders

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USCENTCOM has been engaged in Operation Enduring Freedom since the terrorist attacks on the World Trade Center and Pentagon on 11 September 2001. Operational plans and orders have been issued with missions for Component and Supporting Commanders. To assess campaign progress against strategic, operational, and tactical objectives, USCINCCENT has established a Campaign Objectives Assessment Board (COAB). It's chaired by the Director J8 and comprised of HQ staff, Component liaison officers, and representatives from allied/coalition partner countries. The COAB Chair routinely briefs the CINC, Coalition partners, and other planning boards in the HQ.

To support the COAB, the Assessment and Requirements Division (CCJ8-AR) at CENTCOM has developed a Campaign Analysis / Decision Support System (CA/DSS). The CA/DSS methodology involves establishing a hierarchical set of objectives from the campaign (theater-level) ... to the operational ... to the tactical. It allows for the further breakdown of tactical-level objectives into military tasks, and measures of effectiveness (MOEs). Designated HQ and Component representatives enter objective, task, and MOE information from their respective operational locations. They also set importance factors for each and make assessments, beginning at the MOE level. For military tasks with several MOE, each MOE's "rating" is weighted by its "importance." The net assessment at the military task level is the "weighted average" of the aggregate MOE. This same "weighted average" algorithm is applied at each successively higher level as assessments are "rolled up" to the theater campaign level.

In addition to capturing current assessments as events occur, CA/DSS enables planners to project when objectives/tasks/MOEs are expected to be achieved. Comparisons of "current" vs. "projected" states of campaign progress will reveal where actual results are either lagging, on track, or exceeding planned timeframes. From these aggregate assessments, conclusions can be drawn and recommendations made to USCINCCENT and other planning boards in the HQ regarding required operational adjustments.

Improving Deployment Velocity at the SPOD: A Force Mobility Characteristics Analysis

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Studies of simulated deployments, as well as real-world experience, have repeatedly pointed to the air- or seaport of debarkation (APOD/SPOD) as the most constraining part of the military transportation system. Relaxing this constraint will result in improved flow of military cargo and improved force closure. Reducing the deployment weight of Army units will improve SPOD throughput, however, reducing the weight of all unit equipment across the board may not yield the greatest reduction in unit throughput times. This study hypothesizes that 100 percent mobile and roadable combat units will be more deployable than conventional units, even if their deployment footprint is increased by adding more organic cargo vehicles. A 100 percent mobile unit will be able to clear a sea- or airport of debarkation on its own, eliminating a large number of transportation line haul requirements, thereby improving system flow. Moving from track-based to wheeled systems may potentially reduce the need for heavy equipment transporters or railcars. In this research-in-progress, designed experimentation is used to investigate the relative importance of SPOD resources and infrastructure, as well as the mobility characteristics of the deploying force. A stochastic simulation model of port activity, PORTSIM, is used to simulate the deployment of a notional division-sized force. Unit Equipment Files are modified to model the effect of a theoretical, all-wheeled, self-mobile force. It is expected that experimentation will identify the most significant factors in port throughput as well as provide force design criteria. The results of this research is expected to show that at least as much emphasis be placed on designing forces for improved self-deployability as is placed on strategic lift or deployment infrastructure.

Littoral Warfare Handbook for Surface Combat System Engineering

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Joint Global Positioning System Combat Effectiveness (JGPSCE) Joint Test and Evaluation (JT&E)

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On 29 July 1999, the Office of the Secretary of Defense (OSD), Deputy Director, Developmental Test and Evaluation (DD,DT&E), Strategic and Tactical Systems (S&TS), in cooperation with the Joint Chiefs of Staff and the Services, chartered the JGPSCE Joint Test. Over a four-year period, the JGPSCE JT is conducting a series of test events that focus on joint operations where the Global Positioning System (GPS) is denied or degraded by hostile electronic warfare (EW) or friendly electromagnetic interference (EMI). Specifically, the JGPSCE JT is addressing the following issues:

Issue 1: What is the impact of GPS vulnerabilities on the effectiveness of joint operational missions that require precision engagement?
Issue 2: What changes in joint tactics, techniques, and procedures (TTPs) or system-level mitigation techniques improve or maintain joint operational mission effectiveness in the event of GPS EW and EMI?
Issue 3: What test methodologies can be employed to characterize GPS vulnerabilities in future acquisition and integration programs?

The JGPSCE JT conducted its second field-test -- GYPSY BRAVO Part 1 – from 9 through 25 Jan 02 at Naval Air Station Fallon Range Training Center. The focus of the second test was to assess the impact of EW and EMI on a selected set of weapon systems including precision guided munitions. This presentation will highlight the JGPSCE test concept, methodology, and preliminary results.

UH-60A, SH-60B, SH-60F, HH-60J, MH-60K, UH-60L, CH-60S: Are They All the Same?

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In response to the terrorism of 11 Sep 01, Operation Enduring Freedom is underway. Much of our nation's military might is involved—the Air Force bombers, Navy ships, Marine Corp troops, and Army Special Operations. How will they work together to project power deep into enemy territory? This question has our military reviewing the requirements for joint shipboard/helicopter interoperability. As Operation Enduring Freedom has proved, the US Army and Air Force must be prepared for joint operations. The Office of the Secretary of Defense (OSD) chartered the Joint Shipboard Helicopter Integration Process (JSHIP) Joint Test and Evaluation (JT&E) program back in 1998 to answer such issues.

The backbone of interservice rotorcraft aviation is Sikorsky's H-60—the Army has over 1500 of these airframes, the Air Force has just over 100, and the Navy looks to transition to an all-H-60 helicopter fleet. JSHIP has taken on the unique challenge of conducting an H-60 similarity study. Currently, H-60 similarity research is being duplicated by the services and/or tends to be service-derived independently. This study provides answers in most aspects where H-60s have traditionally been perceived as being equal. Taking unbalanced historical data, this study proceeded to analyze the low airspeed flight characteristics of the different H-60 models. The primary analytical technique was Exploratory Data Analysis (EDA). The results from this analytical method, though not statistically comprehensive, will be used in support of standardization of shipboard launch/recovery envelope development for Navy, Army, and Air Force H-60 variants. This presentation will center on the basic conclusions from the historical data and a challenge to continue to refine flight test analytical procedures.

Conventional Weapon Systems and Homeland Security: A First Look

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As part of the immediate response to the events of 11 September 2001, two PERRY class frigates and one SPRUANCE class destroyer sortied from their respective homeports and took up assigned defensive positions inside Puget Sound. The SPRUANCE was assigned to defend NAVSUBASE Bangor, and the ballistic missile submarines based there. The two PERRY's were assigned to defend metropolitan Seattle, and NAVSTA Bremerton, and the nuclear capable shipyard there. Air cover for the region was provided by Air Force elements based out of Portland, OR. The problem with this assignment was not the obvious beneficial psychological boost to the local civilian population, but rather the capability of the sensors and weapon systems on each if these platforms to defeat the perceived threat. Specifically, it is the authors contentions that these platforms, while designed for and capable of conducting combat against conventional targets, were ill-equipped to deal with a) multiple attacks by commercial aircraft, b) car bomb equipped ferries, or c) other asymmetric physical threats. This paper examines why this is so, and provides some recommendations on future weapon systems to counter these threats.

When does the AEF break? A Quick Look Analysis

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In December 2001, Gen Hal Hornburg, Commander of Air Combat Command (ACC) asked ACC/DRY for a short-term analysis of proposed options for rotating forces to replace those already deployed in support of Operation ENDURING FREEDOM and NOBLE EAGLE. This paper will present the results of that analyses as well as discuss the techniques used to strike a balance between fidelity of the analysis and the limited amount of time allowed to complete the study. Many assumptions had to be made about force rotation processes and data to provide answers literally within a matter of days. Despite the lack of fidelity, the analysis cast new light on the decision-maker's problem. The study found that the key to satisfying critical CINC personnel requirements was the availability of trained, deployable personnel, not force rotation policies. The study recommended that the Air Force focus on validating requirements and/or increasing personnel availability. Gen. Hornberg called the work "low fidelity, high impact analysis". This study became the catalyst for an Air Force-wide review of Aerospace Expeditionary Force (AEF) policies, programs and organizations.

Defining Modeling & Simulation Requirements for the Joint Strike Fighter Program

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Air Power and CID WG-15

Chair: Debra Hall, Veridian Engineering
Co-chairs: Chris Linhardt Veridian Engineering
Ken Mellin, Sparta Inc
Branford McAllister, Sverdrup, **Paul Sheridan**, CACI
Advisor: Karen Childers, Emergent Information Technologies, Inc.
GIF 352D

The following abstracts are listed in alphabetical order by principal author.

Combat Identification Requirements

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In order to field a Combat Identification (CID) system in the Air Force, there is a requirements process that must be followed. Awareness of and compliance with requirements documentation is a critical element in a successful CID system acquisition project. If CID requirements are not documented properly or if a system does not meet the written requirements, the CID system will not get fielded.

A new Air Force Requirements and Generation Process and Procedures Instruction (AFI 10-601) is in coordination, describing a revised process and how some relatively new documents and processes 'fit' into a well designed development and acquisition CID program. While most of the requirements process 'remains' unchanged, there are some new wrinkles that we must be aware of if we want to reach our goal: giving the warfighter the new CID capabilities he needs to meet the modern threat.

This briefing describes the requirements process, as implemented at ACC in support of CID modernization. It covers the guidance in the Air Force instruction, the Joint Mission Needs Statement (JMNS) for Combat Identification, the Capstone Requirements Document (CRD) for Combat Identification, and some specific examples of Operational Requirements Documents (ORD) and System Requirements Documents (SRD). It discusses some of our CID success stories and some of the CID challenges that we must confront in the 21st century. Armed with a better understanding of how the requirements process works, we should be able to make better decisions regarding thrust areas for basic scientific research, engineering development tradeoffs in specific CID programs, and funding decisions in the acquisition process.

Modeling of Red Air Order of Battle Logistics

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This analysis looks at the use of a blue force logistics model to evaluate a plan to isolate an airfield. The model used is the Logistics Joint Analysis Method (LogJAM), which was developed for the Army Research Laboratory as the Knowledge Based Logistics Planning Shell (KBLPS). Its original purpose was to estimate usage and distribution of various classes of supply for the U.S. Army logistics planners. Now, LogJAM is employed to estimate the logistical needs and shortfalls of Red forces.

In this analysis case, the concern is red force logistics of a particular type of aircraft at an airfield. This case was established to mimic a possible military objective. Specifically, it is assumed that a force wants to deny the enemy the ability to use a specific type of aircraft in combat. In order to eliminate the use of the aircraft, either it must be destroyed or the resources that it utilizes must be eliminated. In this case, the goal is to eliminate these resources, in particular, aviation fuel.

One way to obtain the denial objective is by cutting the supply routes to the airfield. However, in this case, the geography around the airfield and the existing local inventory make it nearly impossible to isolate the airfield completely in order to ground the aircraft. So, in addition to supply route isolation, a reduction in the airfield fuel inventory is examined. As a result, it is discovered that both the resupply routes and the inventory must be affected in order to ground the aircraft over time. Then, the model is used for sensitivity analysis in order to give a range of time by which one could expect the aircraft to be grounded.

In addition to modeling aircraft fuel consumption, approaches to modeling aircraft ammunition consumption have been tested. Preliminary work is also being done for this type of supply modeling with regard to naval forces. Provided that the data can be gathered and assumptions are documented, this type of logistics modeling will allow for more realistic impact assessments on methods used to attain military goals.

Evaluation of ATR Systems: Linking Performance to Military Utility

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Automated Target Recognition (ATR) technology is an important capability for processing and exploiting sensor data to support military requirements. Evaluation of ATR systems has focused primarily on the technical performance of the algorithms, particularly under test conditions that are controlled or well characterized. To a lesser extent, evaluations have considered systems that employ a human operator who is assisted by the ATR. While this approach provides quantitative performance results that form valuable feedback to developers and useful information for the end user, it does not directly address the military utility of the ATR technology. This paper will present an approach that links the ATR performance to simple models of military engagements and illustrates the approach with examples. This approach offers several benefits.

- Using the model, observed ATR performance can be related directly to the benefits in specific military applications.
- Performance requirements can be examined in the context of the military mission, leading to a clearer understanding of what is expected from the ATR system.
- The modeling approach supports sensitivity analysis and other excursions to explore conditions that are not directly observed in the ATR performance testing.

Air-to-Ground Radar Imaging (AGRI) Operational Effectiveness Modeling

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Objective: The results of this study will provide quantitative data that defines the AGRI capability and its relationship to other on- and off-board ID systems. Off-board cueing coupled with onboard ESM target detection and classification merge with AGRI capabilities to form a highly effective System of Systems network. The team will evaluate the impact of each of the network components on mission effectiveness by varying their performance characteristics. The purpose is to find the best mix of capabilities for these complimentary technologies.

Scope: In order to more accurately model the AGRI GMTI HRR ATR capability, upgrades to the GLobal Architecture Combat Identification Effectiveness Requirements (GLACIER) tool are required. These upgrades include an improved Pdetection and target tracking module, more detailed modeling of Pdec, Pconf, and Pid accrual, and more robust C2 architectures. The measures of effectiveness (MOE) are launches on the desired targets, launches on wrong targets, time within the SAM threat envelope, and total mission time. The following cases will be analyzed.

CASE #1 - Assigned Target Case.

- An "automatic target cueing" case; that is, the pilot has been tasked to find a certain target in a region of interest and needs help to find the assigned target type/class
- AGRI would then declare potential targets, ranked in order of most likely
- Confidence (P_c) requirement might be relaxed a little because the pilot has reasonable assurance that the target is in the region of interest
- Since the pilot is only asking for matches to a single target type/class, declarations of any other target type in the target database are not desired

CASE #2 - Automatic Target Recognition (ATR) Case.

- For a particular cued or candidate object in the region of interest, the pilot wants to **know with high confidence** the identity of the selected object
- A high confidence of correctly identifying the object (i.e.; P_c in the mid to high-90's) is absolutely necessary
- The database will be reasonably large and the entire target database (or large subset) will be searched
- Keep the possibility of mis-identification extremely low

Conclusions: Analysis results will be a series of system characteristics, MOPs and MOEs for various scenarios and operating conditions. The analysis will define the causality relationships between off-board cueing, onboard ESM and AGRI proper. The improved modeling techniques will be evaluated for inclusion in the AGRI Critical Experiment (ACE) test bed while the analytical results could be used to help design AGRI flight tests so that the best possible results can be collected and analyzed.

Simulation-Based Technology and Investment Planning Experiment (STIPE) Campaign Modeling as Applied on the SensorCraft Technology Assessment

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The goals of STIPE are to reduce the time and cost for developing and maturing promising Uninhabited Air Vehicle (UAV) technologies, to integrate the technologist and the warfighter into the Science and Technology (S&T) acquisition process, and to provide analytical input into the Air Force S&T planning process. STIPE combines engineering-level modeling, design and analysis tools, mission- and campaign-level simulations, and cost analysis tools in a simulation environment to provide analytic information to support investment decisions in the Science and Technology arena. This simulation environment will provide the capability for researchers to evaluate the impact of different UAV technologies in a warfighting environment, providing a link between AFRL technologies and warfighter mission needs.

The STIPE simulation environment is being applied on the SensorCraft Technology Assessment as a proof of concept. AFRLs' SensorCraft initiative is an advanced multi-sensor UAV for standoff ISR. This presentation focuses on the campaign level analysis performed in support of the SensorCraft Technology Assessment. The goal of the campaign analysis is to provide operational measures of merit for return on investment (ROI) analysis to identify promising candidate SensorCraft concepts. The variables derived from the candidate technologies include the basing concept, air vehicle endurance, air vehicle RCS, mean time between critical failure (MTBCF), mean time to repair (MTTR), ground moving target indicator/tracker (GMTI/T) performance, spot synthetic aperture radar (SAR) performance, and air moving target indicator (AMTI) performance. The primary measures of merit at the campaign level are kills by target type and campaign duration required for operational task objectives.

Combat Identification (CID) Vignette Tool

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Despite a general recognition of the importance of CID in military operations, few modeling tools make much of an effort to represent the CID process. Those modeling tools that do address CID typically treat only a limited portion of the problem. For example, most models currently divide the problem into only two types of targets - friends and hostiles. However, there is a requirement that real world operations must perform discrimination between friends, hostiles and neutrals. Because the Joint Theater Air and Missile Defense Organization (JTAMDO) was tasked to assess CID requirements, JTAMDO needed an analytical tool to facilitate its evaluations. The limitations of current models led JTAMDO to sponsor the development of a new analytical tool that could evaluate both current and possible future CID operations.

The JTAMDO sponsored CID model is called the Vignette Tool (VT) because it evaluates the ability of the family of blue systems to develop target identification against a single target at a time. Repeated runs of the VT allow one to evaluate the CID process throughout an entire theater. The VT supports evaluations of multiple types of targets, ID sensor fusion techniques, levels of ID sensor performance, etc. The VT provides tabular and graphical outputs of the probability of correctly and incorrectly declaring IDs as targets progress through a theater. This presentation describes the numerous capabilities included in the VT.

Use of Design of Experiment (DOE) During Tactics Development

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The events of 11 September will profoundly affect military affairs, at every level from strategic to operational to tactical. The fact is, all activities in a healthy military-including tactics, doctrine, weapons acquisition, joint operations, intelligence, and combat support-should be in a constant state of positive change. All of the services have well-established processes in place to develop new tactics in response to these changes. In the Air Force, this process is most obvious during Tactics

Development and Evaluations, or TD&Es. This form of operational testing typically involves operationally representative US platforms, employed by combat qualified crews, in realistic exercises, against representative live threats, capitalizing on digital computation for range support and weapon simulations. In fact, these exercises are run as close to combat realism as possible. Various tactics are proposed and then flown in these realistic scenarios. Results are collected in the form of both objective, quantitative data and subjective evaluations from the participants. Because the exercises are quite complex and involve many players and a large number of variables (some controllable, some not) affecting the outcome, and because the usefulness of tactics is often more opinion than fact, we have typically relied heavily upon the subjective post-mission assessments of the participants, and less on objective, quantitative analysis.

The use of Design of Experiment (DOE) as a methodology for setting up tests and evaluating the results has been essentially non-existent within Air Force tactics development. Even when offered to test managers, arguments against the use of DOE include: DOE will overly constrain the participants in realistic, operational testing; the scenarios are overly complex for DOE; tactics are not suitable for numerical analysis; and DOE demands too many resources. Recently, there has been a movement within the Air Force to utilize DOE during operational testing, though significant resistance remains.

The purpose of this study was to demonstrate the utility of DOE in the tactics development arena in order to dispel the myths that DOE is either impractical or ineffective. The study included both experimental design (for example, the use of factorial experiments, randomization, independent trials) and analysis (the use of ANOVA). The study utilized a Microsoft Excel-based simulation of aerial combat-a relatively simple, but nevertheless high fidelity model of aerial combat engagements involving as many as 8 versus 8 players which was verified using subject matter expertise. We then set up a notional tactics development evaluation, with a number of control factors typical of TD&Es (threat electronic warfare, friendly support assets, threat tactics options, and friendly rules of engagement) to assess two notional friendly tactics (Option A and Option B). The study used a series of engagement simulations to compare the results obtained using sound DOE principles against the most typical methodologies currently used: "one-factor-at-a-time" and "best guess." The study demonstrated the shortcomings of these techniques in comparison with both the efficiency and the effectiveness of results obtained through DOE.

Air Warfare Modeling in JWARS

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The Joint Warfare System (JWARS) model is the next generation campaign-level model for joint analysis, under development by the JWARS Program Office and is currently undergoing Beta testing for limited initial operational capability release. The model is intended for use by the CINCs, Services, Joint Staff, and OSD PA&E, and the current release will be capable of performing force assessment. Future releases will be able to address planning and execution, system effectiveness/trade off analysis, and concept and doctrine development.

This presentation will discuss air warfighting functionality that has been designed and implemented to date in JWARS. Discussion will center around the JFAAC mission planning and execution. This includes inputs from the Land and Maritime Component Commanders, Joint Target Planning, and user specified plans such as the Air Defense Plans, Airspace Control Orders and Collection Plan. The result is a complete Air Tasking Order that includes Air Defense, ISR, CAS, and targeting missions.

Combat Identification Research Fratricide Study

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This study categorized the variables associated with fratricide events and CID using a joint model for CID mission analysis, with principal focus on the Ground-Ground and Air-Ground Mission areas. Depending on the availability of data, the variables included the unique identification of the incident, firing weapon platform, target, casualties, environmental factors, range-to-target and killer-victim pairings, operational environment (physical and tactical mission), and cause. Data sources included investigations, real world operations, highly instrumented Combat Training Center data, Joint T&E results, and Service Safety Center data. Results characterize fratricide, identify the primary causes, provide information to assure that solutions are designed to correct real problems, and provide input to development of a Joint CID Investment Strategy. The study provides insights into the Situational Awareness vice Target Identification debate, validates CINC's IPL listing Ground-Ground and Air-Ground CID as major problems, and verifies the CID = SA + TI hypothesis.

Air Power and CID WG-15

Measuring Performance and Analyzing Confidence in Combat Identification Systems

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Combat IDentification (CID) systems are typically defined, developed, and initially tested by the Research and Development (R&D) community, which consist primarily of scientists and engineers. These systems are then transitioned to the warfighters for operational use.

The R&D community performs analyses based on Measures Of Performance (MOPs) such as, Probability of Declaration (P_{DEC}), Probability of Detection (P_{DET}), Probability of Identification (P_{ID}), Probability of False Alarm (P_{FA}), etc. These types of measures are used to gain performance insights and to provide feedback to the development process. In addition to these metrics, the operational community wants to understand how reliable a system is and how to interpret an individual CID system report. Warfighters ask questions like: "Do I have enough confidence in this report to engage the target?"

The AFRL COMPASE Center has developed and applied a disciplined methodology for the evaluation of cueing and recognition systems. Previous papers have explored an element of that methodology related to the confusion matrix as a tabulation of experiment outcomes and its corresponding summary performance measures. This paper continues that work and defines/develops Probability of Correct Label (P_{CL}) and Report Confidence (RC) MOPs. These measures aim to benefit and bridge the gap between the R&D and operational communities. Scientists and engineers can take advantage of operational insights while the system is still in the R&D phase, while the warfighter stands to gain operationally relevant measures of performance upon acceptance of the CID system.

Results from a study are presented. Outputs from laboratory based state-of-the-art Automatic Target Recognition (ATR) algorithms are used to assess the utility of P_{CL}, and RC.

Simulation-Based Technology and Investment Planning Experiment (STIPE) Metamodeling as Applied on the SensorCraft Technology Assessment

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Metamodeling is a form of data abstraction that allows the creation of a "model of a model." This paper provides a general approach that can be used to support a number of applications where increased fidelity is needed without sacrificing run time performance. A specific example is provided that adds an estimate of clutter loss and jammer loss to the radar range equation for a Ground Moving Target Indicator (GMTI) on-board a Sensorcraft platform. Engineers at Rome AFB use a high-fidelity radar engineering model, BRADS (Bi-static Radar System), to provide detailed estimates of sensor performance. A collection of statistical techniques are used to provide estimates that are well within the 95% confidence interval of the values that would be returned running the BRADS model, but at a small fraction of the time required. Design Of Experiments (DOE) is used to ensure the right data is collected in an efficient manner, regression and curve-fitting methods are employed to provide polynomial representations of the underlying data, and statistical measures are used to validate the metamodel against the BRADS model. This metamodel is linked to the JIMM mission level simulation to support both constructive and virtual events, providing a greater degree of fidelity for evaluating GMTI performance at the mission level. By tailoring the engineering-level fidelity to the weapon system under study at the mission level, a link is created between technologists supporting acquisition and the warfighters that are needed to advocate revolutionary new systems/technologies.

Initial Estimate on the Survivability Effects of Reactive Maneuvering Against MANPADS

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Approved abstract unavailable at printing.

Analysts in the Aerospace Operations Center (AOC)

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As a result of the focus of treating the AOC as a weapon system, analytical support for the warfighter has emerged as a critical topic. The need for analytical support was identified in recent and historical lessons learned. AFSAA is working with the AC2ISRC to bring forth military and civilian analysts to the AOC to aid in decision support to the JFACC and the JFC. Why should analysts be in the AOC? To analyze JFC/JFACC courses of action alternatives; to provide percentages of JFC/JFACC objectives achieved; to test fly and quality check the Air Tasking Order (ATO) prior to execution; to collect, disseminate, and archive information; and to provide mission effectiveness vs. attrition rates. AFSAA received approval from the AOC SDIPT June 2001 for implementation of this initiative. The implementation process requires efforts on five parallel tracks focusing on: operations assessment tools, training curriculum, CONOPS, personnel and manpower, and contingency and exercise support. The issues, challenges, and status of each of these tracks will be discussed. This effort simultaneously represents a significant shift in the utilization of analysts in the Air Force and an outstanding opportunity for analysts to demonstrate their operational capabilities.

MP-RTIP AoA - Early Engineering Modeling and Digital Simulation

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This paper presents information related to the Multi-Platform Radar Technology Insertion Program (MP-RTIP) Analysis of Alternatives (AOA). Engineering modeling played a key role in the MP-RTIP AoA from the outset. The paper outlines how engineering modeling was used in screening alternatives prior to detailed analysis. The number of alternatives was reduced by 50% (from ten to five) using parametric analysis accomplished by the Technology and Alternatives Panel. Ten screening criteria were developed by the AoA team. Key aspects of the engineering analysis will be discussed including sensor Field of View (FOV), as well as aircraft Space Weight And Power (SWAP) margin. SWAP margin was defined in order to evaluate multi-mission (as opposed to single-mission) aircraft suitability. The paper also discusses engineering modeling use in sensor performance evaluation.

Two MP-RTIP AoA models to be discussed include EADSIM and Estimated Time on Station (ETOS). Modeling was conducted by ACC/DRY with input and oversight from the MP-RTIP AoA Effectiveness Analysis Panel. These two models provided insight into operational effectiveness. The EADSIM modeling related to MP-RTIP sensor performance, and was based on work previously accomplished by ACC/DRY. The ETOS modeling discussion includes endurance, reliability, and time to repair information relative to specified operational employment scenarios.

Special Operations/Operations Other Than War (SO/OOTW) WG-16

Chair: COL Tim Hope, Center for Army Analysis
Co-chairs: Robert Smith, Raytheon
Joe Bonnet, Northrop Grumman IT
Advisor: Robert Holcomb, IDA
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The following abstracts are listed in alphabetical order by principal author.

Effects based Operations (EBO) Analysis of Counter Terrorism using Agent Based Modeling

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We present a methodology using existing tools from Project Albert to analyze counter terrorism. Project Albert is a research and development effort of the Marine Corps Combat Development Command (MCCDC) to assess the general applicability of the study of complex adaptive systems (CAS) to warfare, and to provide new methodologies for investigating the results of running such models and incorporating those results with other, more traditional, methods of analysis. Two Project Albert tools used in this CT analysis are Socrates, an agent based model, together with a Generative Analysis (GAn) search heuristic. Our analysis frames CT questions to be answered and poses candidate issues to counter terrorism, We examine terrorist behaviors and personalities modeled in Socrates and address the relationship among Red, Blue and other agents. The GAn heuristic starts by generating a set of possible solutions. These solutions are then evaluated by Socrates. The best solutions with respect to the desired 'effects' are saved. The next set of trial solutions is then generated and the process is repeated. We apply the Effects Based Operations (EBO) to select the 'best of the best' from the set of best solutions. The best solutions from the GAn heuristic search were generated trying to optimize over a set of desired effects 9or goals). Using the concept of EBO, we pick from the best solutions those that are what Dr. Alfred Brandstein calls 'more interesting'-that is, they are more robust, or achieve the effect in some novel fashion. Finally, we analyze the more interesting solutions to gain insights fro the CT mission, e.g., find anti-solutions, i.e., what Red comes up with to counter Blue's best.

Modeling the Global War on Terrorism

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By declaring a war against terrorists and governments who support terrorists in his recent address to the joint session of congress, President Bush erased the distinction between terrorists, terrorist's organizations and state sponsored terrorism. The President also issued a warning order to the American people that the primary focus of his administration would be combating terrorism. This paper discuses a strategy for conducting the war on terrorism in terms of a system and how that strategy must be adjusted over the long-term to compensate for fluctuating components of the war on terrorism. A system to model terrorism and the civilized states that will fight the war on terrorism as systems, a strategy for combating terrorism can be created and analyzed.

Peace Operations Support Tool

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At the 69th MORSS, USCINCPAC presented a briefing on an Australian-U.S. initiative in operations research support for peace operations. The tool being developed under this initiative has come to be known as the Peace Operations Support Tool (POST). The first prototype of POST has been oriented towards functions expected to be exercised during Cobra Gold 02, a Thai/U.S./ Singaporean exercise in May 02. This presentation provides an update on POST development and "quick look" results of an assessment conducted during Cobra Gold 02.

Special Operations/Operations Other Than War (SO/OOTW) WG-16

Common Operational Guidelines

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Recent advances within the U.S. military (including the development of CMO and Civil Affairs policy and doctrine) and within civilian institutions (e.g., formation of codes of conduct and "minimum standards" for humanitarian response) open the possibility of developing a shared set of operational guidelines for both civilian and military organizations responding to SSCs. This presentation summarizes the Institute for Defense Analyses (IDA) hosted workshop held in October 2001 to determine if such Common Operational Guidelines (COGs) could be developed. This Workshop, sponsored by the Assistant Secretary of Defense (Special Operations/Low Intensity Conflict), Office of Special Operations Policy and Support, and the United States Institute of Peace, brought together representatives of civilian and military organizations that respond to humanitarian and peacekeeping crises abroad. The objective of the workshop was to advance civilian-military cooperation during such operations by developing COGs. COGs were defined as "processes to be used by both civilian and military operators to guide their interactions during peace and humanitarian operations." The Workshop proceeded by identifying 15 key recurring policy issues faced by both civilian and military organizations when they are deployed to humanitarian and peace operations. Participants then produced 6 draft COGs to apply to these key recurring policy issues and started work on a number of other COGs. In addition, participants examined how those COGs developed at the Workshop should be vetted among additional civilian and military organizations and gain wider international acceptance in these diverse communities

Using Analytical Tools in Support of a Multi-National Planning Exercise

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On 12 January 2002, planners from 24 countries arrived in the Republic of Korea for a Multinational Planning Exercise, focusing on a Humanitarian Assistance/Disaster Relief (HA/DR) scenario. The exercise, known as Tempest Express 3, is a PACOM sponsored event. The scenario identified a potential refugee and displaced civilian crisis on the fictitious island of Parang Do, located 110 miles off the southwest coast of Korea. At the request of PACOM, Operations Analysis Branch, Combined Forces Command Korea, participated in the exercise and provided analytical support for course of action analysis using available operations research methods. The main planning effort centered on providing immediate relief supplies to the refugee camps using limited transportation assets. Additional requirements included providing security for food storage and initial repairs to the island's infrastructure. Given a variety of intra-theater transportation assets, a linear program was used to provide the planners with the optimal delivery method in order to reduce storage and inherent security requirements. To simulate the delivery process on the fictitious island, a network was built using the software package AweSim. Operations Analysis Branch briefed the linear program and the network at the conclusion of the Multinational Planning Exercise to show the value operations research can provide to an HA/DR crisis.

Analyzing Complex Threats for Operations and Readiness (ACTOR)

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Military planners, defense analysts, diplomats, and legislators need better tools and models to provide them with better insights into where, when and to what extent country instabilities might challenge national security interests so they can anticipate, plan and budget for these possible occurrences in advance. This study draws upon the state strength literature, uses recently developed data-mining tools and draws upon an extensive database that includes annually aggregated data covering political, economic, and socio-cultural domains for some 159 countries over the period 1975-1999 to forecast the likelihood that countries throughout the world will experience a certain level of intensity of instability over the period 2001-2015. The study uses a pattern classification algorithm-Fuzzy Analysis of Statistical Evidence (FASE)—developed by Chen (2000) on behalf of the U.S. Army to identify and analyze the relationships between country macro-structural factors and historical occurrences of instability. A split-sample validation design is used to evaluate the ability of FASE to generate competent

predictions, using the standard performance metrics overall accuracy, recall and precision. The results demonstrate the potential capability of the model to accurately forecast not just the occurrence, but also the level of intensity of country instability six years in advance with about 80% overall accuracy. The forecasts generated through the year 2015 suggest that South Asia and East Africa will continue to harbor highly unstable states. However, most of the states expected to improve their prospects for greater stability are also located in these regions.

Historical Analysis of SSC Operations (Army)

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The Center for Army Analysis (CAA) performed the initial work, called the Stochastic Analysis of Resources for Deployments and Excursions (SARDE), under the sponsorship of the War Plans Division of the Office of Deputy Chief of Staff for Operations and Plans (DCSOPS). SARDE's objectives include the development and demonstration of a methodology to predict the requirement for Army units, by type, needed to support simultaneous smaller scale contingency operations (SSC's) in the future. In October 2000, the Operations Directorate of ODCSOPS requested an update using historical data to the greatest extent possible. The work also needed to use any updates to the methodology. This study, called Historical Analysis of SSC Operations 2000 (HASO 2000), was completed in 2000, revised and updated in 2001 and provided to staff agencies in ODCSOPS for use in their overall force structure requirements analysis.

Determining Homeland Security Force Structure Requirement

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Beginning in the spring of 2000, the Army undertook efforts to change the paradigm of treating Homeland Security as a lesser-included force structure requirement. The results of this shift led to the development of the Army Strategic Planning Guidance (coordinating draft, September 10, 2001). This planning guidance serves as the framework for determining the Army's force requirement to support Homeland Security. There are seven basic mission types that are covered in the planning guidance. The study employs three techniques to determine the requisite force structure for each mission type. The first technique involved collecting known information of current force structure that had a Homeland Security role. The second used a forecasting tool, Stochastic Analysis of Resources for Deployments and Excursions (SARDE) that uses historical events to predict the average monthly force requirement for certain mission types. The final technique involved basic set theory to estimate the requirement based on several possible scenarios. The results of this study were used in the Total Army Analysis '09 process that determines the desired force structure that Army Planners can use to convey it requirement to the Joint Staff and sister services. Lastly, the study demonstrates how the Army is currently supporting the National Command Authority's efforts to ensure the safety and security of the nation.

Balkan Digitization Initiative (BDI)

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Late in 1998, the Commander, US Army Europe (USAREUR), requested that the Program Executive Office Command, Control and Communications Systems (PEO C3S) evaluate the use of Force XXI systems and technologies to enhance the capabilities of the stabilization forces in Bosnia and Kosovo. The resulting material solution consisted of a variant of the Force XXI Battle Command Brigade and Below (FBCB2), packaged on a commercial hardware suite and renamed the Enhanced Information System (EIS). Due to the lack of Enhanced Position Location Radio Systems (EPLRS) and terrain restrictions on line-of-sight, portions of the QUALCOMM OmniTRACS system, a Commercial-Off-the-Shelf (COTS) satellite-based vehicle tracking system, was used as the communications path. Additionally, a QUALCOMM satellite hub ground station was deployed within the USAREUR Theater to provide network management. In Bosnia, there are 140 vehicles deployed with EIS systems. In Kosovo, there are 425 such systems. Last November, 70 systems were fielded to units of the Southeastern European Task Force (SETAF) in Italy. The EIS systems automatically provide patrol vehicles

with their current position location, as well as the position location of adjacent patrols, all without operator action. These position locations are also being sent to a web-based data broker for worldwide dissemination, as well as being entered into the Global Command and Control System (Army) at USAREUR Headquarters in Heidelberg, Germany for inclusion into the Common Operational Picture (COP). A vehicle to vehicle messaging capability exists, and at times is the only communications available to the soldiers on patrol. Architectural enhancements are being made to the system to accommodate multiple communications paths. In addition to OmniTRACS (Ku-band satellites), these enhancements will facilitate the use of L-band satellites, UHF tactical satellites, and EPLRS. When completed, the EIS systems will be able to operate in virtually the entire USAEUR area of operations, which previously had been a major shortcoming.

Emergency Preparedness Incident Command Simulation

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The Emergency Preparedness Incident Command Simulation (EPiCS) is a tool for crisis managers and their staffs to exercise command and control in a realistic but simulated environment. EPiCS can be used to train operations command and control personnel, rehearse operations, evaluate operations plans, analyze systems effectiveness, and develop techniques and procedures. EPiCS allows for agencies at local, county, state, and federal levels to exercise their command structure at multiple levels and, at the same time, allow many agencies to interact and develop or exercise procedures for interagency cooperation across jurisdiction boundaries. Over the last two years, TRAC-WSMR has conducted four EPiCS exercises sponsored by the National Institute of Justice. These exercises have involved various disaster/crisis scenarios including a prison riot, shootings in a school, public disturbances that required mass arrests, and terrorist attacks that triggered a weapon-of-mass destruction (WMD) release in a major city subway. The methods, processes, and results of the project are described. TRAC-WSMR has agreed to conduct overlapping training exercise cycles using EPiCS for the Defense Threat Reduction Agency, (DTRA) to analyze and evaluate site safety response plans and procedures. The plans and emerging results of these efforts will be outlined and discussed.

Multi-domain Counter-terrorism Modeling

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A model of terrorist organizations and their activities must address each of the components of a terrorist network - the command nucleus, field cell, group communications, national hosts, sympathizers, and support assets. Together these create a network that enables a small group to conduct guerilla warfare against any target in the world. Modeling our response to these components will require more than traditional interactive or analytic simulations. An appropriate simulation must include the resources and missions of 1) physical assets like the traditional military, special forces, security systems and personnel, and emergency management teams; 2) intelligence collection against domestic and foreign targets; 3) political actions against governmentally sponsored activities; 4) legal actions against non-governmental sympathizers and organizations that support terrorists; 5) financial and economic sanctions targeted at assets belonging to terrorists and nations that host them; and 6) cultural influences on potential terrorist recruits, national sentiment, and media representation. This presentation will discuss potential frameworks for approaching this problem and discovering the algorithms, variables, and relationships for such a system.

Joint Campaign Analysis WG-17

Chair: LTC Barry Bazemore, TRAC-FLVN
Co-chairs: Mr. Ron Trees, GRCI
Mr. Mike Hopkins, DMSO
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The following abstracts are listed in alphabetical order by principal author.

JWARS: The Assessment Process (V&V, T&E)

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The Joint Warfare System (JWARS) will be a state-of-the-art, constructive simulation that shall provide a multi-sided and balanced representation of joint theater warfare. Users of JWARS will include the CINCs, Joint Task Force (JTF) Commanders/Staff, Services, Joint Staff, Office of the Secretary of Defense (OSD), and other DoD organizations. JWARS will be capable of performing Courses of Action and Force Sufficiency analyses at IOC, and will be able to perform System Effectiveness and Trade-off analysis and Concept and Doctrine Development at FOC.

This presentation will provide insight into the assessment process of JWARS. The assessment process includes both Verification & Validation (V&V) and Test and Evaluation (T&E) which are outlined in the JWARS V&V Plan and JWARS Test and Evaluation Plan (TEP). The V&V Plan, as required by the JWARS ORD, follows the guidance outlined in the DoD VV&A Recommended Practices Guide (RPG), modified, where appropriate, for the JWARS V&V effort. The T&E Plan, as also required by the JWARS ORD, follows the guidance outlined in the DoD 5000.1 and 5000.2 acquisition documents for ACAT III level programs and Automated Information Systems (AISs), modified, where appropriate, for the JWARS T&E effort. The Joint Analytic Model Improvement Program (JAMIP) is the proponent of the JWARS model. The associated JAMIP Executive Committee (EXCOM) and Steering Committee (SC) are the associated approval authorities for the V&V process and T&E process. This presentation will discuss the importance of the assessment process, user interface, verification and validation activities, test and evaluation activities, documentation procedures and reporting criteria. The V&V as well as the T&E processes encompass the internal JWARS office efforts as well as the V&V agent and Operational Test Agencies interface with the user and test community.

Campaign Analysis / Decision Support System for Unified and Component Commanders

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USCENTCOM has been engaged in Operation Enduring Freedom since the terrorist attacks on the World Trade Center and Pentagon on 11 September 2001. Operational plans and orders have been issued with missions for Component and Supporting Commanders. To assess campaign progress against strategic, operational, and tactical objectives, USCINCCENT has established a Campaign Objectives Assessment Board (COAB). It's chaired by the Director J8 and comprised of HQ staff, Component liaison officers, and representatives from allied/coalition partner countries. The COAB Chair routinely briefs the CINC, Coalition partners, and other planning boards in the HQ.

To support the COAB, the Assessment and Requirements Division (CCJ8-AR) at CENTCOM has developed a Campaign Analysis / Decision Support System (CA/DSS). The CA/DSS methodology involves establishing a hierarchical set of objectives from the campaign (theater-level) ... to the operational ... to the tactical. It allows for the further breakdown of tactical-level objectives into military tasks, and measures of effectiveness (MOEs). Designated HQ and Component representatives enter objective, task, and MOE information from their respective operational locations. They also set importance factors for each and make assessments, beginning at the MOE level. For military tasks with several MOE, each MOE's "rating" is weighted by its "importance." The net assessment at the military task level is the "weighted

average" of the aggregate MOE. This same "weighted average" algorithm is applied at each successively higher level as assessments are "rolled up" to the theater campaign level.

In addition to capturing current assessments as events occur, CA/DSS enables planners to project when objectives/tasks/MOEs are expected to be achieved. Comparisons of "current" vs. "projected" states of campaign progress will reveal where actual results are either lagging, on track, or exceeding planned timeframes. From these aggregate assessments, conclusions can be drawn and recommendations made to USCINCCENT and other planning boards in the HQ regarding required operational adjustments.

Modeling JTF Level Command and Control in JWARS

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The Joint C2 decision process involves coordinated actions of the Joint Force Commander and his Component Commander. An ongoing model development effort in the Joint Warfare System (JWARS) model enables one to synchronize a counteroffensive operation. The underlying modeling approach that allows this to execute can be extended to a multitude of other C2 decisions. The model includes rudimentary decision-making with an explicit analytical assessment of some situations. The purpose is to provide a capability for complex integration of multi-service action into a coordinated activity. The basic features include a dynamic command structure, where each commander controls "their" own forces. Each commander acts according to higher-level guidance, but adapts their actions to respond to the local situation. A commander's decisions are made dynamically based on an assessment of perceived truth and its effect on force maneuver decisions.

This presentation will discuss the JWARS current implementation of these concepts, the development path for future enhancements, and the use of these concepts in support of campaign analysis.

Campaign Analysis: Current NEA Theater Missile Defense Baseline

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The Joint National Integration Center (JNIC) is conducting a study for the 32nd Army Air and Missile Defense Command (AAMDC) to provide a campaign-level assessment of current forces' and deliberate plans' ability to accomplish assigned and implied Theater Missile Operations (TMO) tasks in the North East Asia (NEA). The primary focus of the analysis is a rigorous assessment of the 32nd AAMDC's mission tasks. The JNIC setup a realistic battlefield simulation based on the current NEA OPLAN, current theater forces and Time Phased Force Deployment Data (TPFDD). The goal of the project is to examine battlefield inter-relationships and determine strengths and weaknesses in current deliberate plans. The JNIC worked collaboratively with the 32nd AAMDC to investigate methods to mitigate any weaknesses determined to be significant. In addition to the baselining of the campaign, the JNIC conducted excursions to the baseline.

The JNIC used a mission - task - modeling - results methodology consistent with the U.S. Joint Forces Command's (USJFCOM's) development of the Universal Joint Task List (UJTL). The analysis team examined the 32nd AAMDC mission and assigned tasks, and developed modeling inputs and desired outputs to investigate these four tasks: Defended Asset List (DAL) Protection, Active Defense Force Performance, Attack Operations Performance, General Consumption of Assets. Three study objectives anchor the methodology. The goal of the Proof of Principle objective is to ensure the model, COMBAT IV, is prepared to properly simulate the 32nd AAMDC project scenario battlespace, and produce reasonable results. The Campaign Baseline objective has as a goal to examine the baseline ability of currently assigned and apportioned theater forces to deny or negate enemy TBM operations and the resultant campaign level effects of that afforded protection. The Threat Excursions goal is to determine the sensitivity of current baseline TMD protection to differing threat TM campaign courses of action. This paper provides an update on the JNIC project in support of the 32nd AAMDC.

Operations Analysis Supporting the Joint Task Force

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As the Army transforms to the Objective Force, the Legacy Force continues to maintain its overmatch capabilities. Although the US Army Europe (USAREUR) is a key component of the Legacy Force, it also understands that it must maintain trained and ready forces capable of conducting military operations over the entire spectrum. As the USAREUR Headquarters transitions into an Army Service Component Command (SCC) and increases involvement in Joint and Combined operations, the focus of the Operations Research / Systems Analysis (ORSA) Cell shifts from supporting Base Operations (BASOPS) analysis to supporting the Warfighter. This change in focus requires the operations research community to re-look analytical support provided to the operational and tactical levels of command. The US European Command (EUCOM) took steps in this revolution by providing Operation Analysis (OA) Teams to Joint Task Forces (JTF) in the European Theater starting in 1997. This capability is now official and part of the EUCOM Directive 55-11. This document ensures that each JTF has the required analytical resources to plan for and execute its mission successfully. Similarly, the North Atlantic Treaty Organization (NATO) established an Exploratory Team to examine the Operations Analysis support to the Joint Task Force and Component Commanders.

This paper focuses on the capabilities and products that the OA team brings to the fight. The platform to demonstrate the utility of the team is a series of AGILE LION exercises featuring a Southern European Task Force (SETAF) led JTF deploying into Africa for a SSC and our support to an Air Force lead JTF. The authors will demonstrate products already developed and their impact on the success of the mission. Additionally, they will also offer their experiences and propose suggestions about how the OA team can integrate themselves as a key part of the JTF staff.

Logistics in an Theater Warfight

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Most likely, conflicts in the future will have the U.S. fighting with coalition forces. In some instances, the host nation in the theater of operations has agreed to provide logistical support to the US military. Additionally, the host nation provides logistical support to their own forces. What is the impact on US operations when host nation support is degraded, and /or coalition forces cannot adequately support themselves and the US must now provide their logistics support?

This briefing describes how the Simulation and Analysis Center (SAC) continues to analyze the impact of logistics in a theater warfight. In particular, this initial effort determined the potential impact of coalition force logistics requirements on the US logistics infrastructure. Coalition logistics consumption data was estimated using Combined Arms Support Center's (CASCOM) OPLOG Planner and integrated into Enhanced Logistics Intratheater Support Tool (ELIST). The results show the magnitude of support that the US may need to provide when coalition operations exceed their own logistics capability.

Tuning Theater Level Ground Attrition to Division Level Output

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The traditional ground attrition methodology of the Joint Integrated Contingency Model (JICM) has 1557 input numbers. That gives the user a lot of control, but can make it very hard to select a "correct" set of inputs. The default values were chosen by subject matter experts to portray the desired effects of many battlefield conditions relative to each other. But the accuracy of the resulting output cannot be determined without a standard for comparison. Given reliable attrition numbers from a known scenario, correct JICM inputs should be able to reproduce that standard closely.

This study attempted to derive a set of inputs to make JICM's theater-level ground attrition match the output from a series of division level model simulations. The latter were much more detailed than JICM, and assumed to be of sufficiently high fidelity to use as a standard. After creating JICM simulations of the division level battles, the default inputs produced very different attrition output from the division level model. Effects of changing various inputs then had to be explored, followed by attempts to minimize the error between JICM output and the assumed standard. We considered JICM attrition to be "tuned" to the more reliable values when further input changes failed to reduce the error term.

Combined Forces Command Amphibious Analysis III

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The Combined Forces Command Amphibious Analysis III analyzes a branch plan of a Combined Forces Command Operation Plan (OPLAN) employing combined Naval and Marine Forces. For this analysis, TRAC employed its own Vector in Commander amphibious modeling capabilities. TRAC also integrated analytical efforts from a number of joint service agencies such as US Transportation Command's Military Traffic Management Command Transportation Engineering Agency, the Center for Naval Analysis, Marine Corps Combat Development Command, and the Navy's Mine Countermeasures Squadron One to complete the effort. The presentation will highlight the amphibious operations modeling approach, the study methodology, study findings, and analytical insights.

Conventional Forces Database (CFDB) presentation / demo / feedback

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The Conventional Forces Database (CFDB) is a semi-annual product of Joint Data Support (JDS). [JDS is a major component of the Joint Analytic Model Improvement Program (JAMIP) under the sponsorship of OSD PA&E with funding from the Joint Staff (J-8).] CFDB consists of conventional forces, units, equipment, personnel, and other data for all the U.S. Armed Services, including the U.S. Coast Guard, for the current year. Packaged with CFDB is a Force Analyzer toolkit, which can perform user-friendly data queries of various types. Over 50 customers, DoD-wide, make use of CFDB for a variety of purposes.

There will be a short introductory brief, a demonstration of CFDB, and opportunities to both be included on the CFDB distribution list and to feed back any recommended improvements or enhancements to the product.

Sudden Storm: Campaign Analysis and Combat System Order of Priority

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As U.S. forces prepare for the 21st Century, the need for joint modeling and simulation increases. With limited assets deployed forward, the correct force packaging becomes increasingly important, especially in the joint arena. This presentation covers the initial phases of a major theater of war where the defense and no penetration line are critical. Each supporting asset (Army, Navy, & Air Force) is reviewed as to its criticality in the defense and holding of the no penetration line. The analysis provides a first cut cause and effect of the systems and a case for justification and order of priority for each.

Joint Campaign Analysis WG-17

Joint Campaign Analysis Process

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The Quadrennial Defense Review was the occasion for the detailed examination of the U.S. National Military Strategy. Among the tools used in the process were computer models simulating joint combat at the campaign level. This presentation covers the work performed by the Navy staff (OPNAV 816) in coordination and cooperation with OSD PA&E in the analysis of a large scale, near-peer scenario. It covers the analysis process; model selection, scenario interpretation, data collection and validation, and the process of feeding the inputs into formats that the models could transform into actions (the campaign). Detailed are those actions specific to the Integrated Theater Engagement Model (ITEM), the only model that was common between N816 and OSD. OSD PA&E also used TACWAR and JICIM to model the campaign, and the process of comparing the results is also discussed.

TACWAR Attrition Study Issues

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TACWAR is a theater level campaign model used by many organizations including OSD, the Joint Staff and the CINCs. The heart of any campaign model is the attrition element used to determine casualties incurred by each side during the fight. Upon comparison of similar campaigns over time, a series of questions arose concerning TACWAR attrition evaluations, COSAGE valuations and the Anti-Potential Potential algorithm.

This briefing describes an examination of the variable (PWSF) depicting the composition of weapons in the ground battle within TACWAR, the interface of COSAGE and TACWAR valuations, and the APP methodology.

Joint Data Support

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Joint Data Support (JDS) is a component of the Joint Analytic Model Improvement Program (JAMIP), under the administration of the Office of the Secretary of Defense (Program Analysis and Evaluation), with funding from the Joint Staff (J-8). The charter of JDS is to provide and manage data for DoD analytical studies along a broad customer base, including both studies using "JAMIP" simulations (MIDAS, TACWAR, ITEM, ELIST, VIC, and EADSIM), and those using other decision support processes (e.g., the DYNAMIC COMMITMENT seminar wargame). The charter of JDS also includes support for development and fielding of the Joint Warfare System (JWARS).

JDS operates according to a rigorous yet flexible Study Support Process. This brief will provide details of that process, including JDS principles and challenges. There will be several recent examples of JDS-provided data support. A large portion of this brief will cover data support for the development and fielding of JWARS.

Joint and Combined Warfare Analysis at Headquarters USCINCPAC

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The USCINCPAC Research and Analysis Division (J081) is working on an extensive study in support of the USCINCPAC staff. Numerous collaborative agencies and staffs throughout the Department of Defense have aided this study analysis of Joint and Combined Warfare. We are using the Integrated Theater Engagement Model (ITEM) and the Extended Air Defense Simulation (EADSIM) for this analysis. Specifically, we use ITEM to support the assessment of operations plans and alternatives in the areas of Maritime Interdiction, Air Superiority, Ballistic Missile Employment, and Amphibious Operations. EADSIM is used to investigate interactions in greater detail and to provide data resolution to ITEM's integrated theater environment. This presentation will provide an update to the collaborative analysis methodology, modeling techniques, scenario assumptions, and study plan details, and will highlight several preliminary results of the study as well as lessons learned in performing collaborative assessments.

From the 2001 QDR to the 2002 Joint Strategic Capabilities Plan

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The 2001 Quadrennial Defense Review (QDR) outlined a broad strategic framework for the Department of Defense. A considerable amount of analysis will be required over the next several years to interpret, refine, and implement the framework outlined in the QDR. This presentation will present an overview of the new Defense strategy, and discuss the analytical challenges in translating those concepts to size and shape U.S. conventional forces. In particular, the briefing will address some of the issues in using the new strategy to do force apportionment in the Joint Strategic Capabilities Plan (JSCP).

Mobility & Transport of Forces WG-18

Chair: Maj. David Lyle, AFLMA
Co-chairs: Lt Col Robert T. Brigantic, USTRANSCOM/J5-AI
Kelly Lauritzen, USAREUR
Advisor: Robert Drash, GRCI
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The following abstracts are listed in alphabetical order by principal author.

Focused Logistics Wargame 01 (FLOW 01) Intratheater Sustainment Lift Analysis

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FLOW 01 represented the first concerted effort to gather sustainment, operational planning factors, and assumptions from joint and combined force participants for the examination of logistics interoperability and interdependency issues. The portrayal of these forces within a common context provided considerable insights into distribution analysis and opportunities for examination of logistics footprint reduction possibilities, a major FLOW 01 objective. This was most clearly seen during a particularly stressing NEA scenario, adapted from the Mobility Requirements Study 05 (MRS 05). The scenario combined the tactical locations and combat intensities of major force elements, modified to reflect the participating elements of coalition partners, and added in unique logistics planning factors, support relationships, and doctrinal assumptions of the contributing forces. The dynamically changing sustainment requirements were fed into intratheater distribution and lift models to assess the level of transportation sufficiency in meeting sustainment requirements, the results then integrated into a theater level campaign simulation to permit high level examination of joint and combined operational level logistics and support issues.

Interim Division Deployment Analysis Methodology

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This paper focuses on the deployment analysis conducted in support of the operational and organizational (O&O) concept development of the new Interim Division. Deployment analysis has been a key component in the evaluation of alternative Interim Division designs. The analysis compared the deployability of different force structures, including various base cases, and provided a set of reference points in moving towards the Army vision of deploying a division in 120 hours. This analysis provided insight to decision-makers regarding deployment challenges associated with each division design.

The deployment analysis was based on a TRADOC-approved scenario and derived from Defense Planning Guidance. We used the Joint Flow and Analysis System for Transportation (JFAST), a U.S. Transportation Command model, to model the force flow and provide Interim Division closure estimates. This presentation will focus on methodology, end-to-end modeling challenges, and the resulting parametric analysis.

Improving Deployment Velocity at the SPOD: A Force Mobility Characteristics Analysis

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This study hypothesizes that 100 percent mobile and roadable combat units will be more deployable than conventional units, even if their deployment footprint is increased by adding more organic cargo vehicles. A 100 percent mobile unit will be able to clear a sea- or airport of debarkation on its own, eliminating a large number of transportation line haul requirements, thereby improving system flow. In this research-in-progress, designed experimentation is used to investigate the relative importance of SPOD resources and infrastructure, as well as the mobility characteristics of the deploying force. A stochastic simulation model of port activity, PORTSIM, is used to simulate the deployment of a notional division-sized force.

Unit Equipment Files are modified to model the effect of a theoretical, all-wheeled, self-mobile force. It is expected that experimentation will identify the most significant factors in port throughput as well as provide force design criteria. The results of this research is expected to show that at least as much emphasis be placed on designing forces for improved self-deployability as is placed on strategic lift or deployment infrastructure.

A Tabu Search Algorithm for Solving Theater Distribution Vehicle Routing and Scheduling Problems

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Military logisticians lack an automated tool that prescribes favorable vehicle routes and schedules for distribution of goods and services within a theater of operation. This presentation outlines a robust and flexible generalized theater distribution algorithm that prescribes the routing and scheduling of multi-modal theater transportation assets that provide economically efficient time definite delivery of goods to customers. The algorithm solves theater distribution problems such that vehicles make multiple trips and customers are serviced multiple times per planning horizon, hubs are part of the distribution network, and throughput constraints are considered. The algorithm utilizes the tabu search technique, constraint programming, and group theory.

Assessing Effects of Enhanced Fidelity for Ground Vehicle Mobility in Combat Models

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As computer systems exhibit greater computing power, they provide combat model developers the capabilities to enhance the fidelity of their simulations by improving the fidelity of underlying algorithms. Movement, such as ground vehicle movement, is one of the basic battlefield functions and is portrayed at differing levels of fidelity across M&S. Ground vehicle movement is limited by the terrain/environmental factors present in reality, but this fact is not necessarily reflected in current simulations. The need to account for such effects has been acknowledged by the community and is being incorporated in developing simulations. As simulation fidelity is enhanced, however, it is also important to address the question of what increased or decreased fidelity representation buys the user/analyst.

This paper will address effects of improving ground vehicle mobility representation in entity-level M&S by incorporating mobility limiters, utilizing the recent integration of the standard mobility application programmers interface, STNDMob API, with COMBAT^{XXI}. The development and integration were conducted largely by the US Army Engineer Research and Development Center and the US Army TRADOC Analysis Center – White Sands Missile Range. COMBAT^{XXI} is the Army's next-generation brigade and below entity level analytical model. The standard mobility application programmers interface, STNDMob API, allows entity level models to use terrain limited speed factors and is based on the Army's standard mobility model, NATO Reference Mobility Model (NRMM). This integration has revealed some potential impacts on simulation outcomes resulting from dynamically limiting the speed of vehicles and restricting areas of operation based on environmental conditions versus utilizing command ordered or static speeds and will form the basis for the study.

Using Mobility Analysis in Aircraft Design

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Design engineers and operations analysts are seldom in the same room when military weapon systems requirements are being discussed. Any product desiring both high utility and low cost can only be assured if the tradeoffs between utility and cost are made up front before too much time and money is invested.

This presentation presents an application of designing a future airlifter that links design to military utility, balanced with the expected cost of these designs using a CAIV approach. Two models used in this study are the Airlift Loading Model (ALM) and Mobility Simulation Model (MobSim).

A Hybrid TABU Search/Set Partitioning Approach to Tanker Crew Scheduling

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Aerial refueling is a crucial component of modern day operations. A vital part of this refueling process is the individual tanker crews. Constrained by the number of crews available, the USAF must find ways to schedule them efficiently.

This paper details solving the tanker crew scheduling problem with a hybrid tabu search/set partitioning optimizer. We show the synergistic use of the two approaches. The tabu search metaheuristic acts as a column generator for the set partitioning optimizer, while the set partitioning optimizer provides a vocabulary building mechanism for the tabu search.

We show how the model may be used as an analytical tool, as well as an operational scheduler. Statistical results show the increased performance of the hybrid over the existing USAF tool and the tabu search working alone. The results also show how problem characteristics affect the solution process.

The Brigade Assault Bridging Analysis (BABA) Study

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In realigning the Force Structure, rigorous and comparative analysis will be the hallmark to input in the decision making process. Systems being considered for acquisition will have to illustrate their worth to the Army before investments can be made. Recently, the Vice Chief Staff of the Army asked ODCSOPS to evaluate the Wolverine against the Armored Vehicle-Launched Bridge when considering Force Structure and Cost. ODCSOPS asked CAA to assist in the analysis. The purpose of the Brigade

Assault Bridging Analysis (BABA) Study was to perform the comparative analysis of the capabilities of the AVLB against the Wolverine in a worst-case scenario. Given the extensive requirement for bridging assets in Korea, CAA used a Northeast Asia scenario. CAA considered the maintenance readiness, survivability and gap crossing capabilities in developing the model. The result of this study was a tool that allowed Decision makers to assess their particular risk pattern and see the impact on Operational Planning in a Northeast Asia scenario. This, ultimately, provided input to the greater Force Structure and Capital Investment analysis that ODCSOPS provided to the Vice Chief of Staff.

Analysis of Physical Distribution Operations in Maneuver Support Organizations

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As the Army transitions to a distribution-based logistical support system, the criticality of accurately designing and resourcing logistics units has become evident at the highest levels of leadership in the logistics community. Units that reconfigure or transship cargo act as nodes in the distribution system and are of primary importance in this effort. Analysts in the Army's Combined Arms Support Command (CASCOM) have been actively engaged in analyzing these units and are developing analysis tools to aid in the combat developments process. The Army's Deputy Chief of Staff for Logistics sponsored CASCOM's Container/Materials Handling Equipment (CMHE) Study as an initial step in improving the resourcing of these units.

The Analysis of Physical Distribution Operations in Maneuver Support Organizations study effort is exploiting the lessons learned and tools developed during the CMHE Study. Process maps to document operational methods within units

serve as the basis for deterministic analysis tools and simulation models developed using Arena. This presentation shows refinements made to the suite of decision support tools developed during the CMHE Study and illustrates the methodology used to employ them in the combat developments process for distribution units. Interim results comparing deterministic and simulation analysis are also presented.

Manpower Transportation Requirements Determination

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Time Phased Force Deployment Data (TPFDD) identifies assigned, augmentation, and supporting forces to be deployed to the area of operations (JOPES, Vol I). Ideally, this information serves as a record of the count of manpower deployment requirements. In the case of Operation Enduring Freedom, the Air Force is using this data to help determine its requirement for deploying manpower. Alternatively, the deployed personnel data gives the AF a record of personnel at the deployed location, counted as they arrive in theater. Analysis shows the deployment requirements as listed in the TPFDD do not align with the deployed personnel. Specifically, fewer troops required transportation to the theater of operations than were requested by the CINC in the TPFDD, which is essentially a transportation document. This analysis illustrates that pure TPFDD numbers are potentially overstated, and should be used only with discretion for simulations, studies, and analyses. In addition, we offer our own process for assessing the TPFDD and producing a more accurate statement of the manpower transportation requirement.

The Effects of Alternate Performance Criteria on the Composition of Air Transportable Spare Parts Kits

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History proves that for simultaneous deployment of forces for large-scale operations, the demand for airlift soon exceeds its capacity. Our research investigates reducing Readiness Spares Packages (RSP) sizes deployed for Air Force Squadrons by adding airlift criteria -- item cost, weight, and volume -- into the RSP selection process (extending the results by Peterson, King, and Slay). We evaluated our method using an experimental design based on the USAF Aircraft Sustainability Model and F-16, B-52, and KC-135 aircraft RSPs. The experimental results show that RSP sizes can be reduced, but typically at a high increase in cost. However, in some cases the three criteria used together achieved smaller, cheaper RSPs than the developed via the current USAF approach (using only cost-based analysis). These results suggest that this method should be adopted for the RSP selection process to enable cost vs. airlift requirement tradeoffs, and to achieve cost reductions on selected RSPs.

The Development and Testing of a Mathematical Model for Prepositioning Studies

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The Air Force's ability to deploy, employ, and sustain operations in forward locations is a fundamental key to mission success. An integral part of this strategy is equipment pre-positioning, to include: vehicles, aircraft support, consumable inventory, and munitions. This study focuses on defining and developing models to aid decision makers with the afloat prepositioning and deployment of munitions, in an effort to ensure that the right weapons are available when, and where needed. This research places a particular focus on the strategic, global prepositioning of the Air Force's Afloat Pre-positioning Fleet (APF) in an effort to minimize the overall response time involved with offloading these ships and transporting their cargo to the intended point of use.

The model developed in this study is a mixed integer program that was implemented using the General Algebraic Modeling System (GAMS). The model considers the various aspects of pre-positioning (forward operating locations, Standard Air Munitions Packages, and the APF) in order to optimally locate, and configure each APF ship. In addition, the model considers the movement of munitions from land-based forward support locations. The methodology for this model was tested and verified using precision-guided munitions data for a number of scenarios.

In this presentation, we present some background information on pre-positioning and its increased attention in military analysis, the development and testing of our mixed integer programming model, and analysis results.

Evaluation of Combat Service Support Logistics Concepts for Supplying a USMC Regimental Task Force

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One of the primary responsibilities of a Marine Corps Combat Service Support Element (CSSE) is to provide water, fuel, and ammunition requirements for the primary task forces and other Marine Expeditionary Force (MEF) elements. This thesis evaluates existing and proposed concepts on how to best use the CSSE resources of a Force Service Support Group to transport supplies to Regimental Combat Teams over constrained networks with time constraints. A model was developed that optimizes the use of resources, assets, and network routes. The model first solves a capacitated vehicle routing problem, where a set of customers has to be served by a fleet of vehicles within a certain time. The stochastic aspects of the problem are modeled through the use of a discrete event simulation that uses the results of the optimization model. The optimization model goes beyond the traditional routing problem by accounting for special features such as vehicle capacity for each commodity and cargo incompatibility (e.g. fuel and ammunition). The model includes both optimization of routes and simulation of stochastic elements. As a result, this thesis establishes a basis for future studies involved with modeling new concepts in Combat Service Support.

Designing Air Mobility Command's Channel Route Network: A Composite Variable Formulation

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A large number of the daily missions that the TACC at AMC must schedule are channel route missions. Currently, the channel route scheduling process is largely manual. At the beginning of each month, planners must create a 30-day, operational level schedule that contains enough aircraft missions to move all the channel cargo within the system. The schedule must specify the aircraft type, timing, and routing and adhere to all operational rules associated with the aircrews/bases.

We formulate the problem as a network design problem. Our early research focused on using a traditional path formulation in conjunction with column generation to create additional cargo paths and aircraft routes on the fly. However, as a result of the large planning horizon, this approach lacked to ability to satisfactorily model the real world system and yielded undesirable solve times. The long solves times were attributed to a weak LP relaxation. To address these drawbacks, we formulate the problem using composite variables. This approach led to an equivalent formulation with fewer functional constraints and a decreased number of decision variables. Most important, the composite variable formulation has tight LP relaxations, which significantly reduces the time required to solve the model.

Modeling Cadet In-Processing Procedures at the USMA

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Each year in June, roughly 1,200 students arrive at the United States Military Academy (USMA) to begin their transition from civilians and enlisted soldiers into cadets and future officers. The first hurtle that all new cadets must jump is the

completion of their first day called Reception Day (R-Day). During R-Day, new cadets spend most of their morning in-processing.

R-Day planners requested that we create a simulation model in order to test the effects that changes would have on the in-processing process. The planners want to minimize the time it takes a new cadet to get through the system with a minimum numbers of employees manning the stations. They also expressed a desire to reduce the total time that the system is in operation. In order to create this model we used a systematic approach to problem solving that ensured we produced an accurate and effective model. Through the use of stakeholder analysis we determined the specific objectives of our clients. Using these objectives, it was possible to use the simulation model to conduct a thorough statistical analysis of the model and the alternatives. Specifically, the use of Design of Experiment (DOE) and experimental design processes allowed us to test if proposed changes to the base model had a statistically significant effect on the objective values.

Interim Brigade Combat Team (IBCT) Air Mobility Deployment Analysis

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This briefing presents an overview of the methodology used to conduct an analysis of the Air Force's capability to deploy an Army Interim Brigade Combat Team (IBCT). The briefing provides background on the Army's vision to deploy and close an IBCT anywhere in the world within 96 hours. Next, a review of the specific study objectives and scenarios examined will be presented. This will be followed by a review of IBCT operational considerations, airlift parameters, and the study methodology. A "quick look" technique for assessing IBCT closures times from different origins to different destinations will be provided. The briefing will also discuss a more detailed technique for estimating closure times based on two different simulation models – the Airlift Flow Model (AFM) and the Model for Intertheater Deployment by Air and Sea (MIDAS). Lastly, significant IBCT deployment challenges and initial findings will be presented.

Obstacle Crossing Performance of Vehicles

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Obstacles can disrupt, impede, and otherwise influence the outcome of military operations, understanding when and how fast an obstacle can be crossed is required to increase Army model and simulation fidelity. Obstacles other than minefields, such as ditches, berms, cuts and fills, craters, etc can be either natural, man made or reinforced, and depending on vehicle capabilities, these obstacles may be crossable, but at a greatly reduced speed. Obstacle crossing speed is also an issue when comparing performance between wheel and tracked vehicles, additionally the performance of small robotic vehicles must also be considered in emerging simulations. This presentation describes current efforts by the Engineer Research and Development Center (ERDC) to enhance vehicle speed predictions during an obstacle crossing in a SAF environment.

The NATO Reference Mobility Model II (NRMM II) is an Army standard model for determining vehicle mobility performance, primarily by predicting maximum vehicle capable speeds. The effect of a linear obstacle on maximum speed is determined by using two look-up tables. The first is a table of average and maximum (resistance to motion) forces and minimum clearances based on standard obstacle descriptions. If the minimum clearance is greater than the vehicle clearance, the maximum force is used to determine if there is enough available traction to cross the obstacle. If either the clearance or maximum traction tests fail, NRMM II predicts no-go. Otherwise, the average force is added to the total resistance, which is used to calculate the maximum vehicle capable speed across the obstacle. The second table contains vehicle speed versus obstacle height and is used to limit speed due to vehicle and driver acceleration tolerance (2.5g). These tables are in the individual NRMM II vehicle data files, and are produced using 2-dimensional vehicle dynamics software (OBSMOD and VEHDYN II).

The extraction of this information, obstacle description requirements, the implementation of this high resolution data/model into a lower resolution SAF environment are discussed.

III MEF Intra-Theater Lift Alternatives Study

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The study examines ways that the United States Marine Corps III Marine Expeditionary Force can better meet its training objectives by improving the capability to transport its personnel and equipment to the various training sites in the Asian/Pacific region. The study will examine United States Transportation Command as well as commercial transportation alternatives. The measures of effectiveness used to evaluate the alternatives include availability, reliability, transport speed, effect on the local population, the number of days of degraded operations, and cost.

Air Force Futures Game Support (AF-FGS)

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The Center for Army Analysis (CAA) performed the Air Force Futures Game Support (AF-FGS) study for the Deputy Chief of Staff for Operations and Plans (DCSOPS), DAMO-SSP. The primary study question was how can the Army position and deploy a corps, using a mix of prepositioining, forward basing, airlift, and sealift, to close the corps in 10 days. Multiple scenarios were considered iteratively to arrive at a solution that met the sponsor's guidance. The principal finding of the study was that prepositioining equipment in the vicinity of a conflict destination is critical to meet short closure-time requirements. The study also provided insight into the feasibility of sealift. Although theater support vessels (TSVs) will provide fast sea transport in the future, their use becomes impractical for short closure-time requirements.

Enabling Strategic Responsiveness

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CAA performed the Enabling Strategic Responsiveness (ESR) Study for the Deputy Chief of Staff for Operations, War Plans Division. The primary study question was how the Army should configure and place prepositioned equipment (PREPO) sets to aid rapid, global deployment. Three distinct techniques – simulation, optimization, and instability forecasting – were used to answer that question. The study generated several conclusions. First, for the foreseeable future, PREPO will still be required for rapid deployment, for both Legacy and Interim forces. Second, the Army should consider retaining Heavy Legacy PREPO sites and PREPO afloat for possible employment of Legacy forces in Eastern Europe and the littoral region from Iraq to India. Third, the Army should consider adding an Interim Brigade Combat Team (IBCT) PREPO set to the existing PREPO site at Livorno, Italy. Interim and Objective forces can improve their deployment time by stocking PREPO sets at any site recommended in the report. Airlift enablers that bypass maximum on ground (MOG) limitations can increase closure for light and medium forces. IBCTs can close faster by deploying to multiple simultaneous aerial ports of debarkation (APODS). This implies that they should deploy at a lower level, e.g. battalion. Fourth, to improve rapid deployment, both the Army and relevant elements of the Air Force should regularly train on rapid deployment.

CargoLifter Aerial Transportation System (CATS)

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CargoLifter AG is a civilian company planning to build a fleet of 200 heavy lift airships for worldwide operations carrying heavy/oversize cargo [a.k.a. Big Ugly Freight (BUF)]. This study is an initial evaluation of the military potential of this company/airship. The study also is an overall analysis of lighter-than-air (LTA) technology in a military role. Study compares CargoLifter and the CL160 airship to another Ultra Large Airlifter (ULA) proposal from another company. Final part of study is a laydown of how the military could employ ULAs as well as identification of major issues involved, description of the LTA "industry" and an historical perspective of past airship failures and successes.

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The following abstracts are listed in alphabetical order by principal author.

Inventory Management for Items with Sporadic Demand, Part II

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Items with sporadic, or infrequent demand are sometimes thought of as having little impact on readiness. But a weapon system may fail to operate even if it is missing just one of 1000 rarely demanded parts. Although no particular one of these 1000 parts is often called for, *at least one* of them may required every time the system is repaired (perhaps a different part each time.) In a study of 7000 parts (stock numbers) whose absence was holding up DoD maintenance, 40 percent of those were infrequently demanded parts, either stocked in small, arbitrarily set quantities, or not stocked at all.

This finding suggests that better stockage, procurement and repair policies are required for such items. At the 68th MORSS, we presented a new form of procurement policy for consumable items with sporadic demand and assessed the performance of alternative policies for such items. We present the results of extending our analysis to reparable items, and consider new forms of policies for both procurement and repair. Using a retrospective simulation, we compare alternative policies, ranking them in terms of supply performance for a fixed inventory investment.

Focused Logistics Wargame 01 (FLOW 01) Intratheater Sustainment Lift Analysis

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FLOW 01 represented the first concerted effort to gather sustainment, operational planning factors, and assumptions from joint and combined force participants for the examination of logistics interoperability and interdependency issues. The portrayal of these forces within a common context provided considerable insights into distribution analysis and opportunities for examination of logistics footprint reduction possibilities, a major FLOW 01 objective. This was most clearly seen during a particularly stressing NEA scenario, adapted from the Mobility Requirements Study 05 (MRS 05). The scenario combined the tactical locations and combat intensities of major force elements, modified to reflect the participating elements of coalition partners, and added in unique logistics planning factors, support relationships, and doctrinal assumptions of the contributing forces. The dynamically changing sustainment requirements were fed into intratheater distribution and lift models to assess the level of transportation sufficiency in meeting sustainment requirements, the results then integrated into a theater level campaign simulation to permit high level examination of joint and combined operational level logistics and support issues.

U.S. Army Recapitalization -- Reliability Modeling and Optimization

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The U.S. Army is beginning an extensive program to transform its Legacy Force through a major Recapitalization effort. Sandia National Laboratories' detailed reliability modeling methodology and genetic optimization will predict the impact of proposed recapitalization upgrades then optimize the upgrades to provide the greatest performance improvement within budget constraints.

Modeling the Logistics Support for the Airborne Laser's Systems Integration Laboratory (ABL-SIL)

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The Airborne Laser is one of the Air Force's components for the future Theater Missile Defense. The ABL is a Boeing 747 modified to carry a chemical laser capable of locating, targeting and destroying Theater Ballistic Missiles during boost phase. The ABL Systems Program Office (SPO) tasked the Office of Aerospace Studies (OAS) to model the logistics of the ABL's chemicals at the SIL. The ABL Logistics And Turn-Time Evaluation (LATTE) Model answers the questions of how much time is required to refill the chemicals onboard the ABL, and when to refill the supporting storage tanks. The ABL LATTE Model also has the flexibility to answer the same questions once the ABL is deployed. This presentation addresses the development of the ABL LATTE Model, the insights it provides to the ABL SPO and its future capabilities and applications.

Aging Analysis of Army Equipment

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This analysis was performed for the Vice Chief of Staff, Army in support of questions posed on aircraft aging. AMSAA conducted this study to determine the impact of an aging fleet on flight safety. In order to determine whether recent increases in safety of flight messages was due to fleet aging and if aging was apparent in Flight Safety parts (FSP) and Safety of Flight (SOF) aircraft parts, a methodology was developed to identify individual components that were potential candidates for aging.

The study examined the components of four aircraft: Apache, Blackhawk, Chinook and Kiowa. Parts data was obtained from the US Army Aviation and Missile Command's FSP database and SOF parts from the SOF messages dated 1999 – 2001. In order to determine how often these part failures occurred to the point of being replaced, part demands from the Central Demand Database (CDDB) were pulled from 1996 – 2001 for these parts. A statistical test was performed to show if there was an increase in the quantity of parts demanded from one period to another. This test provided a method in which to screen any parts showing an increase in quantity demanded as potential aging parts.

The results were informative. For both the FSP and SOF parts, aging was evident for one of the aircraft, where 48% of the FSP components and 58% of the SOF components showed an increase in replacement rates.

Readiness-based Leveling Supports Contingencies

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The Air Force currently allocates reparables (or repairable parts) to its bases worldwide for both normal peacetime operations and contingencies. Congress provides a limited annual budget with which to buy, store, and repair parts, so a never-ending stockpile of parts is unrealistic. Hence, the need arises to optimally allocate scarce parts to the bases that need them the most.

In April 1997, the AFLMA released the Readiness-based Leveling (RBL) model. The goal of RBL is to minimize expected backorder days by authorizing levels (or reservations) of reparables to the bases that require them. RBL essentially standardizes authorizations among all Air Forces bases based on the worldwide requirement and historical demand data. AFMC runs RBL quarterly in order to allocate the authorizations based on up-to-date demand data.

RBL's distribution of levels to bases has proven to be efficient during peacetime, but what would we do when contingencies occur? The problem with establishing authorizations during contingencies is that historical demand data cannot accurately forecast the need. The AFLMA developed a Contingency High-Priority Mission Support Kit (CHPMSK) approval process. This brief will introduce RBL and discuss a recent CHPMSK approval process that supported Operation Enduring Freedom.

Forecasting the NBC Medical Logistics Impact

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The Nuclear, Biological, and Chemical Casualty Resource Estimation Support Tool (NBC CREST) performs two key functions: estimate casualties for an NBC scenario and the resources necessary to effectively treat those casualties. The resource estimation module uses JRCABs TTT and DEPMEDS databases to compute the time-phased resource requirements for the casualty stream. These data are presented as a series of Excel spreadsheets that can be manipulated by a logistician. NBC CREST was developed in conjunction with the Army Office of the Surgeon General and designed to perform deliberate medical planning at the Corps, Division, and Corps Medical Brigade levels. The resources estimated are Beds, personnel by MOS, Class VIII A by NSN, Class VIII B, and evacuation resources. The tool separates resources needed for prophylaxis, decontamination, and the treatment for illness, in addition to a straightforward enumeration of resources required for patient treatment. The tool can assign the resource consumption to specific medical treatment facilities, allowing the medical planner to optimize the medical footprint and the evacuation network by performing an iterative analysis to eliminate resource shortfalls. Finally, different medical footprints and networks can be compared against user-defined Deployment, Disposition, and Utilization criteria. This presentation will provide an overview of NBC CREST, review the key features of the resource estimator, and discuss the implications for logisticians.

Analysis of Physical Distribution Operations in Maneuver Support Organizations

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As the Army transitions to a distribution-based logistical support system, the criticality of accurately designing and resourcing logistics units has become evident at the highest levels of leadership in the logistics community. Units that reconfigure or transship cargo act as nodes in the distribution system and are of primary importance in this effort. Analysts in the Army's Combined Arms Support Command (CASCOM) have been actively engaged in analyzing these units and are developing analysis tools to aid in the combat developments process. The Army's Deputy Chief of Staff for Logistics sponsored CASCOM's Container/Materials Handling Equipment (CMHE) Study as an initial step in improving the resourcing of these units.

The Analysis of Physical Distribution Operations in Maneuver Support Organizations study effort is exploiting the lessons learned and tools developed during the CMHE Study. Process maps to document operational methods within units serve as the basis for deterministic analysis tools and simulation models developed using Arena. This presentation shows refinements made to the suite of decision support tools developed during the CMHE Study and illustrates the methodology used to employ them in the combat developments process for distribution units. Interim results comparing deterministic and simulation analysis are also presented.

Critical Review of TloaDS and CloaDS Inputs

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TLoaDS is a mid-fidelity, high-resolution, PC-based stochastic, discrete event, simulation of tactical and operational logistics. Its forte is simulating force sustainment, but the new generation introduces the ability to schedule loads or sorties. This improves TLoaDS flexibility to simulate deployment, debarkation, assault, unit maneuver, combat support and CSS sorties; and the competition for resources. TLoaDS is very flexible, with more process parameters than any other model of tactical logistics. Its core module is built on three integrated commercial discrete event simulation packages used by a number of Fortune 100 companies and Department of Energy activities for supply chain analysis. Other modules include preprocessor spreadsheets, reference database manager, study database builder, mapping and laydown tools, task organization and consumption tool, load and mode planning tool, initial resources allocation optimizer, supply chain investigator, map-based supply chain animator, plot and chart tools, table and trace report generators, post processor, and the standard MS Help system. Half of these modules are either new, or have major enhancements since the previous generation of TLoaDS was demonstrated at MORSS last year.

This presentation covers the inputs and algorithms used for consumption, and ordering. How nominal consumption rates are computed, consumption influencing conditions are scripted, actual consumption is computed and monitored, ordering is triggered and scheduled, order amounts computed, orders sent and delayed and assigned to suppliers, is detailed. Areas where we desire improved input validation and process modeling is also addressed. How orders are filled, deliveries are routed and attritted, and material is received is not covered due to presentation time limits.

Global Combat Support System T&E

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The Joint Interoperability Test Command (JITC) is forging new ground as the Operational Test Agency (OTA) for the Global Combat Support System (GCSS). GCSS is a joint strategy to focus combat support information on decisions related to planning and executing military actions through the use of a comprehensive suite of combat support software. Joint GCSS is a family-of-systems (FoS) that act as a paradigm in the way automated information systems of the future will be developed. GCSS is being developed to fill the need for focused logistics called for as one of the pillars of Joint Vision 2010 (JV2010).

GCSS Commander-in-Chief/Joint Task Force (CINC/JTF) provides read-only access to timely, accurate and comprehensive Combat Support information located in various host databases around the world. GCSS (CINC/JTF) provides the ability to view relevant logistics data in a tailored format and allows CINCs and Commander Joint Task Force (CJTFs) to use that data as the input to the tactical decision process.

The size and complexity of GCSS, coupled with the unique acquisition strategy and the dynamic schedule, pose challenges for the test community. JITC has developed a comprehensive strategy for GCSS Test and Evaluation (T&E).

This strategy is designed to meet the unique challenges posed by GCSS and provide timely information to the Warfighter, Department of Defense (DoD) Joint Staff, Director Operational Test and Evaluation (DOT&E), Defense Information Systems Agency (DISA) and the Milestone Decision Authority (MDA).

As the operational tester for GCSS, JITC ensures the Warfighter's perspective is captured as value-added to the development process. During each Field Test JITC assesses the operational effectiveness and operational suitability of the GCSS version release under test.

Through interoperability certification, we ensure the warfighter can obtain information that is accurate, timely, and useful. Based on the Warfighter's requirements for information exchange and through our efforts in evaluating incremental software releases, we help assimilate new and affordable technology more quickly into our fight and win systems.

Modeling Logistics in a Theater Warfight

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Most likely, conflicts in the future will have the U.S. fighting with coalition forces. In some instances, the host nation in the theater of operations has agreed to provide logistical support to the US military. Additionally, the host nation provides logistical support to their own forces. What is the impact on US operations when host nation support is degraded, and /or coalition forces cannot adequately support themselves and the US must now provide their logistics support?

This briefing describes how the Simulation and Analysis Center (SAC) continues to analyze the impact of logistics in a theater warfight. In particular, this initial effort determined the potential impact of coalition force logistics requirements on the US logistics infrastructure. Coalition logistics consumption data was estimated using Combined Arms Support Center's (CASCOM) OPLOG Planner and integrated into Enhanced Logistics Intratheater Support Tool (ELIST). The results show the magnitude of support that the US may need to provide when coalition operations exceed their own logistics capability.

Answering the Right Question: Logistics Network Analysis

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This analysis looks at the use of a blue force logistics model to evaluate a plan to isolate an airfield. The model used is the Logistics Joint Analysis Model (LogJAM), which was developed for the Army Research Laboratory as the Knowledge Based Logistics Planning Shell (KBLPS). Its original purpose was to estimate the usage and distribution of various classes of supply for the Army logistics planners. Now, LogJAM is employed to estimate the logistical needs and shortfalls of red forces.

In this analysis case, we are concerned with the red logistics of a particular aircraft at an airfield. This case was established to mimic a possible military objective. Specifically, it assumed that a force wants to deny the enemy the ability to use a specific type of aircraft in combat. In order to eliminate the use of an aircraft, either it must be destroyed, or the resources that it utilizes must be eliminated. In this case, the goal is to eliminate these resources, in particular, aviation fuel.

One way to attain the denial objective is by cutting the supply routes to the airfield. However, in this case, the geography around the airfield and the existing local inventory make it nearly impossible to isolate the airfield completely in order to ground the aircraft. So, in addition to supply route isolation, a reduction in the airfield fuel inventory is examined. As a result, it is discovered that both the resupply routes and the inventory must be affected in order to ground the aircraft over time. Then, the model is used for sensitivity analysis in order to give a range of time by which one could expect the aircraft to be grounded.

In addition to modeling aircraft fuel consumption, approaches to modeling aircraft ammunition consumption have been tested. Preliminary work is also being done for this type of supply modeling with regard to naval forces. Provided that the data can be gathered and assumptions are documented, this type of logistics modeling will allow for more realistic impacts assessments on methods used to attain military goals.

Mechanical Physics of Failure Initiatives

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This paper outlines the mechanical physics-of-failure (PoF) initiatives being performed by the US Army. The first mechanical PoF initiative is the ongoing analysis of an Army trailer, which uses an integrated process of dynamic modeling, finite element modeling, and durability analysis. The modeling approach starts by using terrain data gathered by the Aberdeen Test Center for use in the dynamic models. The dynamic model used in this project is multi-body model Dynamic Analysis Design Simulation (DADS). DADS is used for a rigid-body analysis and a flexible-body analysis, using finite element analysis. The flexible-body DADS model is used to determine the dynamic accelerations at all points on the trailer. NASTRAN is used as the finite element model in this project. Finally, the University of Iowa, Durability and Reliability Analysis Workspace (DRAW) software tool will be used to integrate results from dynamic modeling and finite element modeling (i.e., dynamic stress and strain) for durability analysis. This project outlines an approach to mechanical reliability analysis that can be used early-on in design.

The tools developed during the trailer project are also applicable to Test & Evaluation (T&E) related issues. The Improved Ribbon Bridge (IRB) and the Dry Support Bridge (DSB) acquisition programs sponsored by the US Army Tank-Automotive and Armaments Command, are utilizing PoF fatigue analysis tools to evaluate the structural fatigue induced by physically simulated loads applied during testing and compare them to real-world usage loads. In this application, PoF tools will enable substantial test cost savings by serving as the validation tool to accredit the physical simulation Modeling & Simulation (M&S) being employed on these programs. Other uses of PoF in support of T&E include Dynamic Modeling, Finite Element Analysis (FEA), and Life Prediction for early evaluations, corrective action verification, and what-if analyses.

Aviation Safety Cumulative Risk Aggregation Modeling—Failure plus Consequences

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To support the Aviation Safety Integrated Product Team, the Aviation and Missile Research, Development and Engineering Center (AMRDEC) asked the U.S. Army Materiel Systems Analysis Activity (AMSAA) to develop a model that aggregates the individual risk from each System Safety Risk Assessment (SSRA) and determines the cumulative risk on an aviation system. The SSRAs address the materiel risk of the component, and do not address risks due to the environment, personnel, doctrine or training. This risk generally correlates to reliability because it considers the component failure plus the consequences. AMSAA developed two models to aggregate the individual component SSRA risks. These models are not predictive, but provide the cumulative level of risk as SSRAs are identified and resolved through time. This allows the decision maker to consider the cumulative risk of the system due to all known SSRAs when deciding whether to accept the risk proposed by the latest SSRA. The first model aggregates component hazard functions and can assess risk at the fleet level and also provide the risk associated with each helicopter tail number. This model can address helicopter-to-helicopter variability and will calculate the risks at any point in the life-cycle. However, the model requires component aging models and component-age data. Component-aging models and component-age data are not currently available for all of the SSRA components. AMSAA has developed an alpha-version tool for this model in Mathematica. The second model aggregates the expected number of yearly accidents for each SSRA over a 20-year time horizon. This model addresses only fleet level risk, and not the individual risk for each helicopter. However, the data requirements for this model match the current state of data collection. AMSAA has developed two versions of this model, one in Mathematica and one in Excel. The model software generates tables and graphs of expected accidents as a function of calendar time and the next n flight hours. The software also calculates and plots accident probabilities. AMSAA also researched risk communication methods currently in use in the risk-mitigation community, and provided alternative communication ideas for the Aviation Safety Integrated Product Team to propose to their decision makers.

Evaluation of Combat Service Support Logistics Concepts for Supplying a USMC Regimental Task Force

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One of the primary responsibilities of a Marine Corps Combat Service Support Element (CSSE) is to provide water, fuel, and ammunition requirements for the primary task forces and other Marine Expeditionary Force (MEF) elements. This thesis evaluates existing and proposed concepts on how to best use the CSSE resources of a Force Service Support Group to transport supplies to Regimental Combat Teams over constrained networks with time constraints. A model was developed that optimizes the use of resources, assets, and network routes. The model first solves a capacitated vehicle routing problem, where a set of customers has to be served by a fleet of vehicles within a certain time. The stochastic aspects of the problem are modeled through the use of a discrete event simulation that uses the results of the optimization model. The optimization model goes beyond the traditional routing problem by accounting for special features such as vehicle capacity for each commodity and cargo incompatibility (e.g. fuel and ammunition). The model includes both optimization of routes and simulation of stochastic elements. As a result, this thesis establishes a basis for future studies involved with modeling new concepts in Combat Service Support

Simulation Analysis of USMA Reception Day

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USMA Reception Day planners approached our research team, requesting that we create a simulation model in order to test the effects that several proposed changes would have on the system. Ultimately, the planners want to minimize the time it takes a new cadet to get through the system with a minimum numbers of employees manning the stations. They also expressed a desire to reduce the total time that the system is in operation. Since we will be creating a simulation, we can see real time, the effect that proposed changes would have on the system.

In order to create this model we will use a systematic approach to problem solving that will ensure that we produce an accurate and effective model. Through the use of stakeholder analysis we will determine the specific objectives of our clients. Using these objectives, it then becomes possible to use the simulation model to conduct a thorough statistical analysis of the model and the alternatives. Specifically, the use of Design of Experiment (DOE) and experimental design processes will allow us to see if proposed changes to the base model have a statistically significant effect on the objective values. Ultimately, the goal of this analysis is to create a tool that will facilitate and aid the decision making process for how to best organize and configure the Thayer Hall system. We feel that through the use of simulation software we will be able to accurately gauge the effect that slight changes on the model will have on the objective values and be able to recommend to the planners the best way to configure the R-Day Thayer Hall system so that their objectives are met with the utmost resource efficiency.

AF Regional Stockage Policy Opportunities

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In an effort to reduce manning and increase efficiency, four AF major commands have regionalized back-shop supply functions to regional supply squadrons. Back-shop functions include equipment management, stock control, mission capability or MICAP, funds management, record maintenance and computer operations. Centralizing AF stockage policies potentially provides opportunities to further the regional concept and implement innovative, effective and efficient AF stockage policies. Therefore, HQ USAF/IL-I tasked the AFLMA to identify opportunities to improve AF support by centralizing retail stockage policies.

In this presentation, we focus on two aspects of the study. First we analyze the stockage policy to reduce MICAPs. The trade-off is that there is a cost associated with each MICAP reduced. The second aspect of the study involves stock control. Specifically, we look at opportunities to laterally support within three major regions, CONUS, PACAF, and USAFE.

Automated Logistics Information to the Air Operations Center

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Currently, no readily accessible, decision-quality, combat support (CS) information is available to the Director of Logistics (A4) to support the Commander, Air Force Forces (COMAFFOR) or the Joint Force Air Component Commander (JFACC) in the Air Operations Center (AOC). Combat support data is manually collected as required and all reports/information are manually generated. Gathering the data is labor intensive and time-consuming, and it results in an ineffective use of personnel.

The goal of the Automated Logistics Information to the AOC (ALIA) initiative was to provide the JFACC staff with current, accurate, decision-quality CS information. To accomplish this, ALIA captures and compiles wing-level CS data, available in Theater Battle Management Core Systems-Unit Level (TBMCS-UL), using Broadsword capabilities. Broadsword is an Air Force Research Lab program that provides users simultaneous access to multiple and geographically separated data sources through employment of a secure web browser. Broadsword automatically compiles the data retrieved from TBMCS-UL systems throughout the area of operation (AOR) into CS decision quality web-based reports and stoplight charts tailored to meet the needs of the AFFOR/A4 and AOC staff.

Model to Improve RAM and Supportability in Requirements & Acquisitions

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The Communications-Electronics Command (CECOM) has developed a Reliability, Availability, Maintainability (RAM) and Supportability analysis model that provides integrated solutions for analyzing and developing Army and Warfighter RAM requirements. The name of this model is the Achieving a System Operational Availability Requirement (ASOAR) model. This model has the potential to dramatically improve the state-of-the-art for implementing DoD 5000.2-R, paragraph C5.2.3.5.8 covering RAM and help support Total Ownership Cost reduction.

The ASOAR model is used to optimally allocate a system readiness requirement to Operational Availability (Ao) goals for its end items being separately acquired. Since the ASOAR model requires only system and end item indenture level inputs, it can be used early in the acquisition cycle to determine the feasibility or costliness of an Ao requirement. Additionally, ASOAR has the capability to analyze the Ao and Mission Reliability for a fleet of similar systems used for accomplishing a mission.

As an integrated RAM and Supportability analysis model, ASOAR will help to determine Mission Reliability, Maintenance Ratio and Ao Key Performance Parameter (KPP) requirements. Model usage will lead to an improvement over the present off-line Reliability and Maintainability (R&M) analyses performed by the Army Training & Doctrine Command. Since Ao is an integral part of the R&M requirements analysis performed by ASOAR, the tool can help the Army to start determining and utilizing Ao KPP requirements in accordance with DoD 5000.2-R.

Integrated solutions help to lead to collaborative efforts across various communities. ASOAR outputs tied to achieving a weapon system readiness requirement help to determine the Ao inputs to use in supportability optimization modeling. Supportability optimization models yield the least cost supply and maintenance concepts for an end item to achieve its inputted Ao goal.

Mathematically, system effectiveness depends on the probability that the system will perform appropriately in a mission, the probability the system will last the duration of a mission without failing, and the probability the system is available to accomplish a mission. The probability the system will last the mission duration without failing is its Mission Reliability and the probability the system is available for accomplishing a mission is tied to its Ao prior to fielding and Readiness Rate after fielding. If ASOAR Ao and Mission Reliability outputs are used in conjunction with performance models that determine the probability that the system will perform appropriately in a mission, system effectiveness can be better analyzed.

Applications of an On Station Availability (OSA) Model

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Many current and future Air Force platforms rely upon small fleets to provide continuous Combat Air Patrols (CAPs). The ability of the platforms to meet their On Station Availability (OSA) requirements depends on aircraft performance, concepts of operation (CONOPS), and logistics. ACC/DRY developed an OSA process flow model that is flexible enough to be modified and applied to different platforms. The model provides a visualization of the process that helps decision makers understand the issues, improving acceptance of the results. To date, DRY has evaluated aspects of the Airborne Laser (ABL), Multi-Platform Radar Technology Insertion Program (MP-RTIP), and the Global Hawk UAV. For example, critical acquisition decisions on the ABL weapon system are driven by the need to service the laser chemicals. The model shows the OSA impact of these specialized chemical requirements. This presentation will discuss the OSA process model, but will focus on the flexibility of the model and its application across a range of issues and platforms, including tradeoffs between reliability and maintainability requirements and sensitivity analysis on force structure and CONOPS.

Applying Simulation to Evaluate Marine Corps Logistics Initiatives

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The Marine Corps is undertaking initiatives to realize resource efficiencies, similar to those achieved by industry leaders, while maintaining or improving support to forward deployed units. Several of these initiatives include creating a more efficient logistics chain by realigning fulfillment processes and reducing the logistics responsibilities of combat arms units. Metrics have been established to determine how well the logistics chain supports the warfighter. These are also used to measure the effectiveness of the initiatives based on ongoing proof of concept experimentation. We show how we apply simulation to provide another experimentation medium to estimate the impact of these initiatives on the logistics chain metrics. By modeling the Marine Corps' order fulfillment process we are able to show how changes in information and product flows impact the expected quality of support provided to Marine Corps warfighters. We are also able to show how moving logistics responsibilities upstream in the logistics chain impact resource migration. Problem definition, model development, and conclusions will be discussed.

Optimization of Appointment Systems

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Appointment systems are ubiquitous throughout DoD. Application of this research includes scheduling related to airfields, just-in-time loading dock operations, cargo ship unloading, and personnel appointment systems. Here, appointment systems are modeled as a finite queuing system in which arrival times are predetermined and service time distributions are idd and phase-type. Cost is defined as a linear combination of waiting times of each arriving item and the idle time (or overtime) of the server. This work shows that long-accepted scheduling heuristics are far from optimal, and it provides precise methods for evaluating and optimizing the cost of a given appointment system. I'll also describe accurate heuristics for sequencing arrivals, a critical consideration that has received little attention in the literature. The research also provides a lesson for us as to when to reject simulation and pursue mathematical modeling instead.

Determining Inventory Levels: Do we have the right criteria?

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Although the concepts for the Army's Future Combat System (FCS) have not been fully developed, one of the premises of the Objective Force is focused logistics. "Sustainability in a full spectrum Army will require a combat service support reach capability that allows commanders to reduce stockpiles in theater while relying on technology to provide sustained velocity management and real-time tracking of supplies and equipment. (FM 1)." Historically, tactical stockage levels have been largely determined by demand data. This presentation will examine alternate methods for determining tactical inventory policies.

Manpower and Personnel WG-20

Chair: LTC Michael J. Kwinn, Jr., USMA
Co-chairs: Dr. Tanja Blackstone, Capable Manpower Supporting Technology
MAJ Veronica S. Zsido, HQ USAREC, PA&E
Mary Filippell, National Security Agency
Dr. Al Robbert, RAND
Bell Hall 22B

The following abstracts are listed in alphabetical order by principal author.

Decision Support for the Career Field Matching Process at USAFA

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Matching USAFA cadets to their initial Air Force career fields is time-consuming and largely manual process. In a previous talk, we introduced an optimization-based approach that determines these matchings, given known cadet job preferences, cadet standing relative to their peers, and AF needs within each career field. In this talk, we describe a suite of models that supports the entire process, from assigning cadets to one of two records-review panels, to the consolidation of the ranks and scores generated by these panels, to the determination of AF needs for each career field, to the actual matching of cadets to career fields. This suite of models is bound together using a simple menu-drive interface that enables personnel officers at USAFA to operate this process more efficiently, to provide cadets with better assignments to their initial career fields, and to meet AF accession needs.

CONLOG, An Application of Logistical Regression Analysis

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CONLOG is an important tool in the analysis of adverse impact against demographic groups in the promotion process, or of any selection process, and is of key interest in diversity management and Equal Employment Opportunity (EEO) concerns at the National Security Agency.

CONLOG is an application of logistical regression analysis that relates the probability of promotion to multiple factors, which can include qualifications of the candidates and demographic characteristics as well. It produces regression results that relate to the effect of each factor on the probability for promotion with "all other effects being equal." The program also produces results in the format of MULTEVENT (an objective statistical analysis of selections for promotion by demographic groups based on a "fair-share" representation of each demographic group in the eligible population.) Therefore, CONLOG enhances MULTEVENT by taking qualifications into account. This is important in the analysis of the effect of age category in promotions, since qualifications are more important in this type of analysis than in the analysis of race and gender.

The presenters have successfully applied CONLOG to promotion selections for civilians in regards to age category. Their results, as well as the data analysis behind the successful application of CONLOG, will be presented

US Army Hispanic Market Analysis

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This presentation will discuss the U.S. Army Recruiting Command's goals, as well as the Command's strategy, for recruiting high quality young men and women from the "Hispanic Market" to meet the needs of today's Army and the future *Objective Force*. The briefing will address collection efforts relating to population demographics data and recruiting

production data; provide analytical assessments of the United States Army recruiting Command's achievements within the Hispanic Market over time and also with respect to other DoD services; discuss current barriers and market misperceptions; and the application of market research to the development and application of programs and initiatives to attract applicants from this rapidly expanding recruiting market. The goal of this project was to determine through analyses the most effective method to target our recruiting efforts within the Hispanic Market. The techniques evaluated during this project included psychographic and demographic profiling, trend analysis, geo-coding and thematic mapping. The presentation is designed for those interested in military recruiting challenges presented in a manpower analysis framework.

The Workforce Projection Model: Design, Construct, Implementation and Model Results

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This presentation describes the development and design of a model designed to provide the Director, National Security Agency and his deputy directors with quantitative information regarding his civilian workforce over varying time horizons. Analysts from the Workforce Assessment Team (WAT), an applied Operations Research cell within the Human Resources department at the National Security Agency, created this workforce projection model using MS Excel and populating it with data retrieved from current and historical personnel files. The model is a fractional-flow Markov model that steps the workforce through time, one year at a time, hiring and attritioning employees. The workforce is characterized by skill category, Congressional budgetary program element, and assigned directorate. The model beings the base year with the starting workforce as of the first day of the fiscal year, and projects to the time horizon requested by the customer. The model uses as an input attrition projections from another model, the Attrition Model. The Attrition Model, also developed and implemented by the WAT, is an entity-level Markov model that explicitly models attrition to great detail.

The Workforce Projection Model was designed to be extremely flexible and allow the analysts to investigate the impact of "what-if" hiring scenarios, re-assignments of segments of the workforce from one directorate to another, and so forth. Modules were written into the model to perform involuntary separation (Reduction In Force, RIF) and outsourcing of segments of the civilian workforce (e.g., GROUNDBREAKER, the National Security Agency's outsourcing of the information technology infrastructure). Model results are intended to gauge the impact of these various scenarios upon the workforce over time. Senior management uses these results to investigate workforce strategies that have major personnel and financial impacts.

This presentation will focus on the development and design of the Workforce Projection Model. Results from the model will be discussed, and its implementation in MS Excel. Key to any successful model is the data that populates it. Workforce data will be displayed and its structure in the model explained. Results from the model will be discussed, and selected "what-if" scenarios run for senior management will be presented.

Student Value Model

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Approved abstract unavailable at printing.

Sailor Career Management: Transforming Navy Personnel Distribution and Assignment through the application of Collaborative Intelligent Software Agents and Web-Based Marketplaces

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Existing systems do not meet the Navy's requirement of placing the right Sailor/Marine in the right job with the correct training and in a timely fashion. The result for Navy is 10,000 unfilled sea billets with the resultant manning of deploying ships at between 80 and 90% of required manpower. There does not exist an incentives-based rewards system that entices

service members to voluntarily request assignments to less desirable assignments. This results in these jobs experiencing continuous manning shortfalls. No process exists to ensure that Sailors/Marines are guided through a career path that has proven successful for professional growth. There is also significant distrust and dissatisfaction in the current processes based on the element of human intervention, the perception of favoritism and the limited number of choices. Sailors and Marines today spend an enormous amount of time – away from their primary responsibilities, attempting to gather facts about new jobs and the associated information regarding the geographic area, schools, spouse employment, etc. Even with several hundred assignment managers involved in this process, the information most frequently sought by Sailors/Marines is at best thorny to collate and frequently unavailable.

Unlike previous applications of intelligent agents, web-based applications and reward systems, which are standalone, we propose a solution that merges these multiple components into an integrated career management system. We will introduce collaborative intelligent software agents able to deliberate into the distribution and assignment process. These agents will represent the interests of Sailors and Marines and USN/USMC commands and activities. The agents will gather critical information for use in job matching, career mapping, manpower analysis, personal interests, etc. A marketplace environment will be employed in which the Sailor/Marine agents and the command agents will search out, analyze, negotiate and consummate optimum job matches that meet the personal and professional needs of the service member and the manpower needs of the command at the most efficient and economical costs. Part of these costs will include the various assignment incentives agreed to by both parties. To ensure the most economical use of limited resources, multiple agents, both individual and command, will "bid" for jobs through an interactive auction mechanism. With the use of agents, it is expected that virtually all "human" assignment managers will be eliminated. A minimal number of individuals will be necessary to adjudicate intractable cases. Sailors/Marines will be given greater control over their assignments and commands will have the opportunity to attract the types of individuals needed to meet their manpower requirements.

We expect to deliver the following products over the next five years: Career Case Manager (CCM) technologies; a Distribution Incentive System (DIS); Web-based Marketplace for Sailors/Marines and Jobs; and the integrated Sailor/Marine Career Management System (S/MCMS). The CCM will provide single point of reference for assignment, education, training, and promotion information to the service member to ensure career goals are attainable. The DIS will manage the equitable award of assignment incentives while ensuring adequate incentive levels are applied to difficult-to-fill assignments. The Web-based Marketplace for Sailors/Marines and Jobs will serve as the "virtual mall" where service members and commands will search, analyze, negotiate and reach agreement on optimal assignments. The integrated S/MCMS will merge these products into a single focal point enabling Sailors and Marines to manage their military careers. Significantly less time will be spent searching for job and "chamber of commerce" information resulting in more time on the job and increased productivity. Provided with relevant job information with which to make informed career decisions, Sailors and Marines will be more likely to choose to remain in their respective service, increasing the likelihood of retention and thereby improving readiness with more experienced service members.

A Comprehensive Model of the Employee's Turnover Decision Process

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Retaining qualified employees is a substantial element of the military's human resource function. The long-term retention of employees has increased in importance as a result of the military's technological modernization. The extensive high-cost training required of today's sailor and the decrease in the size of the military's active forces have made long-term retention critical to the military mission. In any environment in which retention is a primary goal, an essential first step in controlling attrition is the development of an in-depth understanding of the employee turnover decision process. The current study will expand the body of knowledge pertaining to the turnover decision processes followed by employees. Specifically, the Lee and Mitchell [1994] four-decision path, voluntary turnover model will be tested. The decision processes of employees that quit or considered quitting their jobs in the last year will be compared to the four decision paths identified in the model. It is posited that each employee included in the study, quitters and stayers alike, will use a decision process that uniquely matches one of the four paths. In addition, the Lee and Mitchell [1994] model will also be extended to include economic factors. While the model provides a framework that allows researchers to examine the relation between decision paths and economic factors, prior research has not specifically investigated this issue. It is hypothesized that economic factors are associated with the type of turnover decision processes chosen by employees. A sample of 50 people who have quit their jobs within the past year and 50 people who have considered quitting but ultimately made the decision to remain employed will be used to test the model. Data collected to date are supportive of the proposed hypotheses. They also suggest that economic consequences play an important role in certain situations and specific types of decision processes.

Analysis of DOD's Civilian Personnel Issues

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DOD is a "total force" composed of active and reserve military personnel, civil service and other civilian employees, and contractor personnel. Compared to the analyses of military personnel issues, relatively little attention has been given to civilian or "total force" issues. Further, a decade of downsizing has left DOD facing human capital challenges that mirror those facing the rest of government, but are comparatively massive in terms of scope and budgetary implications. How can the analytic community help DOD in its strategic management of human capital--designated by GAO as a high-risk area government-wide—especially civilian personnel? Specifically, what are the issues in assessing DOD's human capital strategic planning, organizational alignment, leadership, talent, and performance culture—the five parts of GAO's human capital self-assessment framework?

Developing Aerospace Leaders (DAL) Development Tool

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The DAL Development Tool (DAL-DT) is a critical element of the change that DAL brings to the Air Force. Built upon the Global Combat Support System-Air Force (GCCS-AF) architecture, DAL-DT will be an automated information system that supports the DAL construct Air Force-wide. It emphasizes "self-service" human resources, improves efficiency, and reduces costs by empowering the workforce, including commanders and Air Force personnel themselves, to interact with the system at multiple levels. DAL-DT will be the Air Force standard architecture for integration of Human Resources Information Technology.

The DAL DT demonstration not only provides the vision for the IT capability but also outlines the new methodology the Air Force will be using in requirements definition and personnel management.

MULTEVENT, A Statistical Analysis of Adverse Impact Against Demographic Groups for any Selection Purposes

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MULTEVENT is an important tool in the analysis of adverse impact against demographic groups in the promotion process, or any selection process, and is of key interest in diversity management and Equal Employment Opportunity (EEO) concerns.

The MULTEVENT procedure provides an objective statistical analysis of selections for promotion by demographic groups based on a "fair-share" representation of each demographic group in the eligible population. If the proportional representation of those promoted from a particular demographic group is much higher than would be expected based on the eligible population, then the promotion results are designated as significantly positive, and that demographic group is said to be over-represented. Similarly, if the proportional representation of a demographic group is much lower than expected, the results are significantly negative, the group is said to be under-represented.

MULTEVENT is an application of the Fisher's Exact Test, and shows the probability of the deviations from the expected "fair-share" value. For example, if the probability of the actual number of selections for a demographic group is less than 5% under the assumption of a fair-share representation, this would be a significant deviation and would indicate that there may be underlying factors, or perhaps discrimination, which could explain the demographic group's under-representation. This would be an indication for more investigation by EEO organizations.

The presenters have successfully applied MULTEVENT for many years to promotion selections for civilians in regards to demographic characteristics of race and gender. A significant portion of the successful application of this procedure was the accurate capturing of data, and the stratification of the data into skill category and grade level data sets. Their results will be presented.

Improving Selective Reenlistment Bonus (SRB) Allocation Procedures in the Army

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This study developed and estimated a new model of Army enlisted retention behavior, with particular emphasis on the responsiveness of retention to changes in the SRB program. A two-choice Annualized Cost of Leaving (ACOL) framework was applied to estimate retention effects for soldiers making stay/leave decisions in Zones A, B and C. Historical data for fiscal years 1990 through 2000 was used for the estimation.

The analysis explored differences across skills and provides quantitative evidence that can be directly applied to support the formulation of SRB policy. The project also included the development of a prototype, spreadsheet-based analytical tool that allows Army program managers to apply the research results to allocate SRB resources efficiently.

Considering Applicant Interests in Initial Classification: The Development of Job and Occupational Interest in the Navy (JOIN).

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Empirically, job performance, employee satisfaction, and employee retention are contingent upon appropriately matching recruits with their desired occupation. The costs associated with losses in productivity and personnel can be astronomical. In an effort to minimize attrition and dissatisfaction among Navy personnel, Navy researchers have focused on the development of an inventory that can inform applicants about activities and work environments in the Navy, and measure the applicant's interest in these activities and environments.

A new measure of vocational interest, Job and Occupational Interest in the Navy (JOIN), is being developed for use in conjunction with a new set of job matching algorithms, the Rating Identification Engine (RIDE), to help provide a better match between recruits and specific occupations (i.e. ratings). It is hypothesized that the simultaneous utilization of the JOIN interest measure and the RIDE ability components will improve the match between the Navy recruit's abilities and interests, an ultimately serve as a means of increasing job satisfaction, performance, and retention, while decreasing first term attrition. Current efforts have focused on developing a rational, conceptual model, guided by psychological literature, and a series of Subject Matter Expert (SME) interviews. The presentation will focus on the conceptualization, development and proposed validation of the JOIN model.

Army Advertising LEADS Prioritization Analysis

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This presentation will discuss the problem, data preparation, experimental design, modeling effort and results of the United States Army Recruiting Command's advertising leads prioritization analysis. The goal of this project was to determine the most effective method to prioritize the quality of an advertising lead in terms of the likelihood to enlist in the United States Army. The techniques evaluated during this analysis included logistic regression, polynomial statistical networks, K-nearest neighbor, classification and regression trees (C&RT) and neural networks. The presentation will also highlight the differences in output between the various modeling techniques and methods of deploying the results for improved efficiency in recruiting operations and advertising practices. The presentation is designed for those interested in using advanced modeling and data mining techniques for problem solving.

Manpower and Personnel WG-20

Analytical Support for Proponent Functional Review

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Biannually, an Army proponent must brief the Army's leadership on the state of the branch. This briefing is called the Functional Review. Most proponents are not supported by organic analytical assets. Through outreach efforts, strategic personnel strength management techniques were applied to support the Air Defense Artillery's Functional Review. The results adjusted the current perceived status and identified strategic trends to generate alternatives for the direction of the branch in the near and far terms.

The Attrition Model

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The presenters designed, developed and now exercise an Attrition Model on behalf of senior management at the National Security Agency. The model is Markovian based, that was developed in the spring of 1996 to better understand and then forecast how the early-out and incentives offered to Agency civilian employees would affect attrition figures and help the Agency achieve its downsizing goals. The model has been in use consistently since 1996, with the presenters making significant enhancements, updates to accurately reflect changes in the Agency, and calibration of underlying transition figures over this time period. The model's accuracy has been fairly good when early-out and incentive programs offered to Agency civilians have remained constant.

The Attrition Model incorporates the Agency full-time civilian population to the entity level and uses historical attrition rates to project how many individuals will leave Agency service in a given time period. The model calculates regular and early retirement based on the attributes of age and years-of-service as these are the primary factors involved in an individual's retirement decision. Resignation, on the other hand, is tied more closely to an individual's skill field; therefore the model makes resignation projections based on occupational codes and age. The model is best used as a predictor of overall Agency attrition expectations, but has been use at lower level of analysis for organizations and groups.

The Attrition Model and its results will be presented.

Development of a Strategic Recruiting Research Roadmap

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PNNL was asked to develop a strategic recruiting research roadmap for the US Army Recruiting Command (USAREC) to help reestablish and manage recruiting research. The roadmap development was built on the USAREC Campaign Plan Strategic Plan, and Strategic Objectives and incorporates and expands upon the Recruiting Research Consortium Model. Recent military and civilian recruiting research was reviewed primarily to determine research knowledge gaps that warranted research to provide the critical research information necessary to effectively support the recruiting needs of the Army. This paper provides specific research recommendations, the associated rationale, and includes a decision process for comprehensive strategic recruiting roadmap with the detailed decision points overlaid upon the annual funding cycle.

Manpower and Personnel WG-20

Modeling a "No Gap" Navy

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Officer manpower gaps, to include deltas, differences, and mismatches between authorizations and inventory, occur throughout the Navy, in various patterns across different communities and in different grades. Given the dollar costs as well as the soft costs (such as performance, capability, and readiness) resulting from such gaps, we assert that communities must be managed independently, systemically, and to authorizations in order to prevent such gaps. We have developed a system dynamics model to explore the dynamic relationships between officer management policies. Within the model, promotion rates, promotion timing, longer careers and other management decisions are dynamically linked for Navy communities. This presentation briefly describes the model, elaborates upon the dynamic interaction between management policies, and explores the likely differences in managing selected Navy communities should the Navy decide to manage officers to authorizations.

Assessing the Impact of PERSTEMPO Legislation on the Marine Corps

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In August 2001 the FY02 Marine Corps Studies Board called for a study to determine the impact of the FY01 National Defense Authorization Act PERSTEMPO legislation on the Marine Corps. This legislation provides for a $100 per day high deployment per diem (HDPD) payment to any Marine deployed in excess of 400 of the preceding 730 days. Studies and Analysis Division, Marine Corps Combat Development Command was tasked to estimate the burden of HDPD to the Marine Corps, propose actions that could reduce HDPD costs, and explain potential effects of those actions. A literature review identified many theories describing personnel tempo but little real data. Due to this lack of data a baseline model was developed in Excel that estimated PERSTEMPO from unit operations tempo (OPTEMPO) profiles. The baseline model evolved into a collection of unit specific sub-models due to variation in OPTEMPO across unit types. This composite model was used to examine the impact of training and deployment schedules on the overall Marine Corps' HDPD cost. A Monte Carlo simulation model of an individual PERSTEMPO profile was also constructed to assess the detailed effects of several proposed courses of action. This presentation will describe the analytical approach of the PERSTEMPO models and how they were employed to meet the study objectives. These models provide a valuable environment for evaluating courses of action to reduce HDPD costs while maintaining unit readiness and retention rates.

The Status of Navy and Army Recruiter Productivity

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This presentation will provide a statistical review of recruiter productivity for the Navy and Army for the last 24 months. It is apparent that each service has its own philosophy when it comes to recruiter productivity. What are the major differences between them? Is it the systems that they use, geographical challenges they face , or something else? First, we will address their individual recruiting process and summarize the inter-service differences. Key resource will be examined and competitive advantages determined. Next, a comparative analysis, using some external criteria from private industry, will make an assessment on the recruiter productivity for each service. Using techniques such as multiple regression, T-Test, and ANOVA, a comprehensive analysis will evaluate the primary measures of effectiveness for each service.

The Rating Identification Engine (RIDE) Ability Components Initial Development

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This presentation focuses on the conceptualization, development, testing, and refinement of the RIDE ability model. The RIDE project utilizes ideas from psychology, education, economics and operations research to create a set of algorithms which can help guide Sailor-Applicants to Program/Ratings. By guiding our research with empirically-established models of human behavior, our goal is to develop RIDE as an intuitive and accurate model of match between the Sailor's abilities and interests and the rating's requirements and features. By establishing a good applicant-ability to job-requirements match between the Applicant-Sailor and the Program/Rating, we can minimize the number of unfilled jobs for the fiscal year due to over-qualification wastage, and maximize training success in the fiscal year.

The Evil of Model Complexity

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Complexity in manpower models is attractive in that it potentially allows greater model fidelity, validity, and analytical or predictive power. However, there are also drawbacks. Complexity can result in the evils of long run times, unwieldy software, greater opportunity for model error, and even a reduction in predictive accuracy. In this tutorial we will examine how model complexity arises in the application of important manpower modeling techniques, illustrate how it creates problems, and discuss how to manage it.

US Army College Market Analysis

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This presentation will discuss the United States Army Recruiting Command's goals, as well as the Command's strategy, for recruiting high quality young men and women from the "College Market" to meet the needs of today's Army and the future *Objective Force*. The briefing will define the term "College Market"; address collection efforts relating to institutional data population demographic data, and recruiting production data; provide analytical assessments of the United States Army Recruiting Command's achievements within the College Market over time and also with respect to other DOD services; discuss current barriers and market misperceptions; and project future achievement within this lucrative recruiting market. The goal of this project was to determine through analyses the most effective method to target our recruiting efforts within the College Market. The techniques evaluated during this project included psychographic and demographic profiling, trend analysis, geo-coding, and thermatic mapping. The presentation is designed for those interested in military recruiting challenges presented in a manpower analysis framework.

Readiness WG-21

Chair: Daniel L. Cuda, Institute for Defense Analyses
Co-chairs: Rebecca Kirk, Center for Naval Analyses
Advisor: Mr. Joseph Angello, Director, Readiness Program & Assessments – ODUSD (Readiness)
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The following abstracts are listed in alphabetical order by principal author.

Issues Related to DOD's Difficulty in Correcting Unified Commanders Readiness Deficiencies

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Since the mid-1990's, the Joint Chiefs of Staff have validated a number of significant readiness deficiencies of the Unified Commands that limit these warfighters' ability to effectively synchronize and use their forces to meet national objectives. These deficiencies include shortages of intelligence, surveillance, and reconnaissance platforms; intelligence personnel; command, control, communication and computer systems; and information security.

While most of these issues have been raised for a number of years, there has been little success in correcting most of them. For some issues, it has taken several years to assess the problem and consider potential solutions. Even after a solution has been identified, it is often projected to take several years to fully field the equipment or personnel needed. For other issues, it has been determined that partially correcting deficiencies is an acceptable risk since fully corrected has been deemed to be unaffordable. While some of these issues will require multiple billion dollar expenditures, neither DOD nor the Joint Staff have identified the total cost to correct all deficiencies.

American Industrial War Readiness

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The Vietnam took a heavy toll on the psychology of the American armed forces. In the early 1980's and as part of the Army's soul searching process an exhaustive, confidential Army survey had been conducted among its officers and senior leaders. The 1985 published report only confirmed what many knew to be a profound spiritual loss among our soldiers and what it would take to revive it.

The survey was ordered by the then Chief of Staff, General John Wickham, with an introductory letter stating: " Because this study will shape the future of our officer corps, we need your candid opinions..." The survey report was compiled from answers to two long questionnaires. The first was sent to all 436 serving officers in the four grades of general, of whom 333 (or 77%) replied; the second was sent to 23,000 randomly selected officers (from colonel to lieutenant) of whom 14,046 replied (or 62%). In those six grades were a total of 92,000 officers. Three of the many results tabulated were:

- Sixty-eight percent agreed that, *"the officer corps focused on personal gain rather than selflessness"*
- Among the general officers nearly one half concluded that, *"senior Army leaders behave too much like corporate executives and not enough like warriors"*
- Fifty percent of the officers agreed that, *"the bold, original creative officer cannot survive in today's Army"*

One of the fallout's from this disquieting revelation was a major exodus of talented people into civilian life. But where did they go? Who did they work for? What energies of innovation and imagination were lost to private enterprise? We will never know exactly, of course, but there may be a way of harnessing future officers who leave active duty by offering an alternative Reserve Officer career program aimed at a selected reservists who find themselves in responsible positions in industry as Vice Presidents or even Chief Executive Officers.

How to design a possible career path and what it might mean to defense industrial readiness and now, perhaps, industrial security will be the theme of this paper.

The paper has two parts: first, a discussion on the defense industrial readiness crisis of the early 1980's and how an industrial - reserve career program might have worked examining the fighter aircraft industry as an example. The second part will focus on a modern appraisal of the defense industry and how a reserve career program might work and be expanded to support special needs of homeland security.

O&M Program Balance Metrics and Links to Forces Readiness

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Operations and Maintenance (O&M) funding is a clear driver of current unit readiness. Despite this consensus opinion, few metrics have been developed within the O&M budgeting process to aid the evaluation of funding adequacy. Preliminary research is underway to identify O&M budget metrics using data submitted within the PPBS process. This presentation introduces a budgetary taxonomy for O&M Sub-Activity Groups (SAG) now in use within the Office of the Secretary of Defense, and presents broad initial metrics designed aid the evaluation of O&M budget estimates at the Service Component level.

Control Charts for Navy Cruise Metrics

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USS Harry S Truman (CVN-75), with air wing CVW-3 embarked, deployed from November 2000 through May 2001 to the Arabian Gulf in support of Operation Southern Watch (OSW) and maritime intercept operations (MIO). Four months were spent in the Gulf – from the beginning of January through the end of April – the longest Gulf stint of any recent carrier/air wing cruise. All cruise long, key metrics covering the air wing's sortie-generation, readiness, and maintenance were tracked relative to control charts generated from historic data. Each week, the charts were updated and forwarded to key players attached to the carrier, the air wing, and the battle group commander's staff. Ultimately they made their way each week to Commander, Carrier Group TWO – RADM James "JMAC" McArthur.

The control charts provided a standard for comparison where none had existed before. For example, during a cruise air wing readiness isn't flat – it follows a distinct bowl-shaped pattern (one could even call it a "bathtub") of starting off high with the fly-on, bottoming out at the mid-cruise steady-state, and ramping back up for the end-of-cruise fly-off. The control charts capture that cruise pattern and represent an informative way to track the metrics. For most of the metrics, HST/CVW-3 operated within the parameters set by earlier deployments. A few metrics had HST/CVW-3 pushing the bounds to improve upon the historic averages.

Readiness and the Ability of US Forces to Train Overseas

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US military units based overseas face a variety of constraints from host governments that are making it increasingly difficult for them to train. They have the most difficulty meeting their training requirements for large maneuver operations, live ordnance practice, and night and low altitude flying. The consequences of the constraints include (1) training deployments, (2) a lack of realism in some of the training, and (3) not being able to complete all necessary training.

While these issues are frequently discussed among unit personnel, these affects are not readily apparent in readiness reporting. In fact, there appears to be a disconnect between the inability of units to complete required training and a degradation in reported readiness. At the same time the consequence of this practice undermines the usefulness of readiness reporting. Therefore, senior DOD leadership, such as the Senior Readiness Oversight Council, may be unaware of the adverse impact of training limitation in making strategic decisions.

Supplemental Metrics for Navy Supply and Maintenance

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Traditionally, the Navy has relied on metrics based on downtimes due to supply and downtimes due to maintenance to detect supply and maintenance problems. Based on an examination of maintenance, supply, and flight data, we have concluded that these metrics have hidden tremendous fluctuations in the amount of time awaiting parts and have overstated the amount of downtime due to maintenance. We have therefore concluded that the standard NMCS/PMCS and NMCM/PMCM are not good indicators for problems in their respective areas. As an alternative, we recommend that total elapsed maintenance times and what we call total primary maintenance hours be used to flag maintenance problems. Similarly, total maintenance action supply hours and fill rates should be used to identify supply problems.

Air Force Deployment Requirements Determination

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A Timed Phase Force Deployment Data (TPFDD) identifies the specific forces, functional support and resources required to execute the plan and provide closure estimates for their movement (JOPES, Vol I). Ideally, this information serves as a record of the count of manpower deployment requirements. In the case of Operation Enduring Freedom, the Air Force is using this data to help determine its requirement for deploying forces. Alternatively, the deployed personnel data gives the AF a record of personnel at the deployed location, counted as they arrive in theater. Analysis shows the deployment requirements as listed in the TPFDD do not align with the deployed personnel. This leads to the question - what is the true requirement for the Air Force - the document that requests troop movements as determined by the CINC (the TPFDD), or the number of personnel that have actually deployed and are fighting, and winning, a war? This analysis shows that pure TPFDD numbers are potentially overstated, and should be used only with discretion for simulations, studies, and analyses. In addition, we offer our own process for assessing the TPFDD and producing a more accurate statement of the deployed manpower requirement.

Improving Readiness through Accurate Spare Parts Industrial Base Capability Assessments

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Department of Defense policy calls for each of the services to plan for and provide sufficient war materiel to commence execution of expected war scenarios. To achieve this state of readiness, the services can plan for spare parts to be available from peacetime operating stocks, war reserve inventories, or from the industrial base. DOD's policy is to rely on the industrial base to the maximum extent possible. War planners need accurate assessments as to when spare parts will be available from the industrial base during wartime so that they can estimate the amount of war reserve material that needs to be bought. Inaccurate or insufficient industrial base capability estimates cause war planners to reduce their risk of running out of parts by increasing war reserve inventories. Recently, Congress has shown a willingness to fund war reserve spare parts inventories, which further emphasizes the need for accurate industrial base capability assessments. We will discuss industrial base capability assessment methodologies and their potential impact on readiness and budgets.

Analyzing Anti-Terrorist Tactical Effectiveness for Force Protection using X3D Graphics & Agent-Based Simulation

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U.S. Naval Forces are increasingly the target of terrorist attack. There is a strong need to provide emerging technologies to forces afloat for analysis and visualization of tactical posture when defending warships in port. The SAVAGE research group in the Modeling, Virtual Environments and Simulation (MOVES) Institute at the Naval Postgraduate School (NPS) is building a large public-domain library of models and prototyping tools. We construct tactically interesting virtual environments using Extensible 3D (X3D) graphics, providing interactive displays either in standalone mode or via the Web. A sophisticated series of interactive Web-based 3D scenarios utilize georeferenced terrain, humanoid avatars, physically based models and networked agent-based simulation. For example, a sophisticated scenario for U.S. Marine amphibious assault shows key spatial relationships that can easily be overlooked if solely analyzing in a 2D context.

What Does it Really Cost the Navy When Wholesale Supply Runs Out of Inventory?

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The Navy uses a classical inventory model for determining when to procure spare parts for their wholesale supply. In the classical model, the average annual inventory cost is minimized by minimizing the sum of three component costs: procurement cost, holding cost, and shortage cost. Procurement cost and holding cost are relatively straightforward to calculate but shortage cost is more abstract - what does it really cost the Navy when the wholesale supply runs out of inventory of a spare part? We show how to use the Navy's retail model, which they use to determine sparing levels on aircraft carriers, to find "shadow prices" for aircraft availability. We use these shadow prices to determine shortage cost. We did a sample computation for one spare part: a hydraulic oil cooler. We determined that an additional seven spare parts at the wholesale supply would have cost an additional $10,000 per year in procurement and holding cost but would have reduced the shortage cost by over $100,000 per year.

Forecasting Readiness: A Regression Analysis

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According to many experts, the readiness of America's military forces deteriorated through the 1990's, and is still of concern today. A key measure of combat aircraft readiness is the mission capable rate, a measure used to indicate the percentage of aircraft able to perform their primary wartime missions. The Air Force currently uses the Funding/Availability Multi-Method Allocator for Spares (FAMMAS) time series forecasting model to predict overall mission capable rates for each aircraft type in inventory. While FAMMAS does a great job of predicting mission capable rates based on funding data and other associated planning factors, it does not incorporate or explain the key logistics and operations drivers that influence mission capable rates, which limits its effectiveness as a management and decision-making tool. Our research developed explanatory and predictive models that provide more insightful forecasts, by examining over 600 variables from aircraft reliability, maintainability, operations, and personnel areas, and ten years of quarterly data. Our final explanatory model contains six variables, reflecting personnel, aircraft inventory, cannibalization hours, and aircraft down time for maintenance. It also includes an interaction factor that indirectly measures a unit's ability to provide on-site training. After reserving 20 percent of our data set for validating the model, we found the average prediction error (confidence interval halfwidth) to be 1.9 percent. In addition, two predictive models were selected from 50 candidate models, based on mean absolute percentage error and average prediction error criteria. One provides very good point estimates, while the other is a better long-range predictor.

Analyzing the Cost Growth in Navy's Depot Level Repair of Aircraft

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The Navy's cost per flight hour for depot level repair (DLR) of aircraft components rose sharply during the 1990s. We analyzed this trend by decomposing into five detailed trends in: surcharge (the tax that pays for the supply system and other costs), the price of a given market basket of components, the mix of components, the number of repairs per flight hour, and other costs. We found that from FY96 to FY01, the number of repairs per flight hour was a dominant trend. We then analyzed the effect on the trend of repairs per flight hour of the aging of the fleet and found that it was the dominant factor. The estimated effect of age provides a way of adjusting future budgets for aircraft aging.

Development of Updated DoD Readiness Reporting System

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Abstract not available at printing.

Designing in Readiness: ASOAR Model to Improve RAM & Supportability in Requirements & Acquisitions and Supportability in Requirements and Acquisitions

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The Communications-Electronics Command (CECOM) has developed a Reliability, Availability, Maintainability (RAM) and Supportability analysis model that provides integrated solutions for analyzing and developing Army and Warfighter RAM requirements. The name of this model is the Achieving a System Operational Availability Requirement (ASOAR) model. This model has the potential to dramatically improve the state-of-the-art for implementing DoD 5000.2-R, paragraph C5.2.3.5.8 covering RAM and help support Total Ownership Cost reduction.

The ASOAR model is used to optimally allocate a system readiness requirement to Operational Availability (Ao) goals for its end items being separately acquired. Since the ASOAR model requires only system and end item indenture level inputs, it can be used early in the acquisition cycle to determine the feasibility or costliness of an Ao requirement. Additionally, ASOAR has the capability to analyze the Ao and Mission Reliability for a fleet of similar systems used for accomplishing a mission.

As an integrated RAM and Supportability analysis model, ASOAR will help to determine Mission Reliability, Maintenance Ratio and Ao Key Performance Parameter (KPP) requirements. Model usage will lead to an improvement over the present off-line Reliability and Maintainability (R&M) analyses performed by the Army Training & Doctrine Command. Since Ao is an integral part of the R&M requirements analysis performed by ASOAR, the tool can help the Army to start determining and utilizing Ao KPP requirements in accordance with DoD 5000.2-R.

Integrated solutions help to lead to collaborative efforts across various communities. ASOAR outputs tied to achieving a weapon system readiness requirement help to determine the Ao inputs to use in supportability optimization modeling. Supportability optimization models yield the least cost supply and maintenance concepts for an end item to achieve its inputted Ao goal.

Mathematically, system effectiveness depends on the probability that the system will perform appropriately in a mission, the probability the system will last the duration of a mission without failing, and the probability the system is available to accomplish a mission. The probability the system will last the mission duration without failing is its Mission Reliability and the probability the system is available for accomplishing a mission is tied to its Ao prior to fielding and Readiness Rate after fielding. If ASOAR Ao and Mission Reliability outputs are used in conjunction with performance models that determine the probability that the system will perform appropriately in a mission, system effectiveness can be better analyzed.

Sustainability of Aerospace Expeditionary Force Support to Operations ENDURING FREEDOM and NOBLE EAGLE

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In December 2001, Gen Hal Hornburg, Commander of Air Combat Command (ACC), asked ACC/DRY for a short-term analysis of proposed options for rotating forces to replace those already deployed in support of Operations ENDURING FREEDOM and NOBLE EAGLE. This paper will present the results of that analysis as well as discuss the techniques used to strike a balance between fidelity of the analysis and the limited amount of time allowed to complete the study. Many assumptions had to be made about force rotation processes and data to provide answers literally within a matter of days. Despite the lack of fidelity, the analysis cast new light on the decision-maker's problem. The study found that the key to satisfying critical CINC personnel requirements was the availability of trained, deployable personnel, not force rotation policies. The study recommended that the Air Force focus on validating requirements and/or increasing personnel availability. Gen Hornburg called the work "low fidelity, high impact analysis." This study became the catalyst for an Air Force-wide review of Air Expeditionary Force policies, programs, and organizations.

Deployability Readiness Metrics

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The ability to rapidly task organize and deploy units is a critical component of Marine Corps force deployment planning and execution (FDP&E) processes. The Force Service Support Group (FSSG) faces unique challenges because it is not organized in garrison as it will deploy or fight in an actual contingency. By doctrine, a Combat Service Support Element (CSSE) must be formed from resources that reside in the functional battalions of the FSSG. The purpose of this study is to identify a set of metrics that the FSSG can use to assess their ability to deploy on short notice. We examined existing readiness reports and procedures to assess their utility to gauge deployability readiness, and identify potential shortcomings. Deployability readiness metrics are proposed to help commanders objectively determine the ability of units to meet deployment requirements and highlight potential risks. Using existing data, these metrics quantifiably link current readiness status to the ability of the FSSG to deploy effective CSSEs.

Installation Privatization and Readiness

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The Honorable Thomas A. White, Secretary of the Army, stated "We will find ways to make more efficient use of our resources by bringing the best business practices of Corporate America into our department." Recent legislative changes (Title 10, Section 2667) have enhanced the authority of military departments to lease non-excess real property for cash or in-kind consideration. Any revenues derived from the lease of Army property under this legislation is provided back to the Army. As with any underutilized inventory, the goal should be to look for new ways to gain value from the inventory. The Army has an expanded tool for resourcing the upgrade and maintenance of its installation facilities. This presentation will propose a framework for installation commanders to select which private organization (among potential bidders) to enter into an outlease with.

Analytic Support to Training WG-22

Chair: LtCol Joseph G. Smith, USMC
Co-chairs: Maj Linda Kotulan, Center for Army Analyses
Mr. Bruce Harris, Dynamics Research Corp
Mr. Mike McDevitt, Digital Systems International Corp
Advisor: Mr. Brian R. McEnany, FS, SAIC
GIF 253A

The following abstracts are listed in alphabetical order by principal author.

Evaluating PC-Based Simulators in Flight Training

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The presentation will review lessons learned in the Air Force's MicroFlight and the Navy's Micro-Sim Flying simulators that are adaptations of the Microsoft Flight Simulator program. Specifically, the presentation will examine test and evaluation procedures, measures of effectiveness, reliability and maintainability, and cost benefit analysis outlined in the study plans of the F-15 Flight Deck Systems and Procedures Trainer and the Undergraduate Navigator PC Based Simulator being inserted as proof-of-concepts into Air Force Air Education and Training Command (AETC) flying training curriculum. The presentation will conclude with a discussion of the challenges of testing, evaluating, and measuring the effectiveness reliability, maintainability, and cost of inserting technology into undergraduate flying training programs.

Morphing Games into Computer-Based Learning

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Briefly, the presentation will discuss the game technologies used and the challenges of converting the respective game technologies to computer-based learning systems. Three of these commercially available game technologies have been inserted into Air Force Education and Training Command (AETC) training curriculum. These include the Game Show Assessment Strategy to Reduce Attrition (GASTRA), Air Force Microflight Simulator, and "Norma Brown" a first person perspective emergency response command and control simulator. The presentation will examine the distinctly different measures of effectiveness used including student attrition, study hours, test scores, time to proficiency, to determine if GASTRA and Air Force Microflight Simulator were successful converted to computer-based learning systems. The presentation will conclude with a discussion of measures of effectiveness.

Instructable Agents for Strategic Center of Gravity Analysis

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Students at the U.S. Army War College are discovering new insights into Center of Gravity analysis. They both teach and learn from an intelligent agent software program called Disciples, created in the George Mason University Learning Agents Laboratory (LALAB). This paper will describe a multi-faceted research and development effort that synergistically integrates research in Artificial Intelligence, Center of Gravity analysis, and practical deployment of an agent into Education.

Analytic Support to Training

Using Process Modelling and Simulation to Optimize Warrior Performance: Developing the Most Efficient Military Organization.

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Military organizations are inherently very complex, characterized by multiple interdependencies operating in a constantly changing environment. This complexity is exacerbated when human nature and group dynamics are factored into the equation. Much of the complexity is caused by six major factors key to performance in all organizations: the people or workforce, the functions assigned and the processes used to accomplish those functions (the work), the organizational structure, the physical facilities, the supporting technology and equipment, and the supporting budget or economics.

While optimizing all six components of the organization is both ideal and ultimately critical to optimal performance improvement, this paper focuses on the most used/abused facets of mission performance, the workforce (training), the work (the most ignored component), and their interdependencies. Closing a performance gap in a military organization requires reframing the basic performance paradigm. In order to achieve a "most efficient" end-state in a military unit, the work and workforce must be optimized and sustained. This can be achieved only by carefully defining the ideal state of the processes that must be performed to accomplish the unit's mission and the subordinate tasks associated with each of those processes. This definition is achieved BEST by employing proven modeling techniques such as business process analysis and reengineering methodology to optimize the work. Once high-resolution models of unit task performance requirements are constructed, simulations can be run to find the optimal process mix to achieve mission success. Once processes are optimized, the work attendant to each process can be further deconstructed to provide insight into task definition and associated performance attributes. It is this phase of optimization analysis that task-based training or other very targeted performance improvement interventions are designed and developed. Simulations employed in the initial BPR efforts are then employed to visualize and "bench-test" the training and/or performance improvement products before fielding to ensure that the interventions directly support unit performance goals.

Once the work and the workforce are optimized, that end-state must be sustained. Continuous evaluation provides for work process adjustments in light of the constantly changing nature of unit mission tasks performed. Concurrently, task performance by the individual military member must be supported in meaningful ways such as job performance aids provided only as the need for that support occurs.

In very simple terms military units must strive to perform their work "better, faster, cheaper." Quick results performance fixes are not the answer. What are required are more intensive and comprehensive analysis of soldier, sailor, or airman performance needs (training and job aids) and simultaneous optimization of the work itself (processes and workflow). The costs of analysis are more than returned through higher efficiencies in the military unit workforce and its work. In terms of the Department of Defense bottom line, more analysis IS less cost and better use of tax dollars and the return on investment is measured in improved READINESS.

Modeling Maneuver Warfare with SEAS

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The goal of military education is to help soldiers understand the nature of war and to teach them how to think logically and creatively about war and during war. Every great military leader understood that success in battle is attributed to well-trained forces. We intend to show that wargaming can play a major role in the course of instructing maneuver warfare techniques. Modeling and Simulation has a pivotal role to play in providing trainers with sound analytical support on training activities designed to teach maneuver warfare. Our study employed Systems Effectiveness Analysis Simulation (SEAS), an AF Toolkit campaign level model. In the past SEAS has been used by senior AF decision makers to determine future space systems policy. Future uses could be to provide analytical support to scenario construction and evaluation of the learning process, for individual or collective training. Our research applies the maneuver warfare principles from the Maneuver Warfare Handbook at the company level and below. It can be used to teach students to make educated decisions through a coherent, logical thought process. Advanced techniques such as unit

skills, conducting a specific type of attack, and employing combined arms can be taught and demonstrated. The SEAS model was developed in such a way that it allows for "tactical programming", which permits the application of maneuver warfare techniques. Most computerized games try to decide "who won" by rewarding "kills". SEAS, however, is designed to give the decision maker or instructor or student insight into the effects of variables. There is no right answer in maneuver warfare, only timely and logical ones.

Employing Simulation to Train the Objective Force: Laying the Foundation Now

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As part of the Army's transformation, the Objective Force Soldier will have state-of-the-art weapons and support systems that will increase his lethality, survivability, and overall combat effectiveness on future battlefields. Land Warrior is one such system. Future training plans will train and sustain soldiers and units on the operation, maintenance, and employment of Land Warrior. We view Computer Based Training (CBT) that integrates Interactive Multimedia Instruction (IMI) and simulation as the ideal vehicle to accomplish this task. This presentation introduces a vision for simulation in the CBT-IMI framework for Land Warrior. This is validated by assessing the effectiveness of a robust simulation framework currently being employed at the United States Military Academy in cadet military instruction. Cadets are being trained in both mounted and dismounted warfare via simulations rooted in commercial off-the-shelf (COTS) software. These simulations are pseudo-immersive in nature, where cadets operate in a computer based simulation environment, confronted with the sights and sounds that attempt to replicate the fog of war. By evaluating simulation in collective training—in the context of small unit offensive and defensive operations—we provide a basis for effective scenario development, software reengineering, and preliminary experimental design to evaluate Land Warrior sustainment training.

Rapid Initialization of Course of Action (COA) Tools Using Data from GCCS

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Over the past several years, simulations have been increasingly used as a way of developing and evaluating courses of action (COAs) during staff-level training exercises. However, one of the major drawbacks in using such tools in the inability to rapidly populate such simulations with data that exists in C4ISR systems. In the majority of instances, unit data is read directly off of the available C4ISR system and input manually into the COA simulation. This process can be time consuming and is prone to errors - due to both the manual nature of the process and the fact that the tactical picture may change significantly by the time all the data has been input.

During the Navy's Global '01 Wargame last year, an automated process for initializing the Naval Simulation System (NSS) based directly on available track data in the Global Command and Control System (GCCS) was used for the first time in an exercise. The interface leverages standard M&S and C4I architectures - employing components based on the DII COE and the High Level Architecture (HLA). Use of this capability led to a significant improvement in the speed in which NSS could be initialized, and also the accuracy of the COAs evaluated. Because it was used directly by the NAVFOR cell in the exercise, it helped to streamline the C2 decision process for the training audience. The success of this application has led the Navy to employ it on the USS Coronado during the upcoming Fleet Battle Experiment - Juliet (FBE-J), during the summer of 2002.

This year the GCCS-NSS interface was extended to include a second COA application - the Integrated Theater Engagement Model (ITEM). The GCCS-ITEM initialization capability will be used during exercise Reception, Staging, and Onward Integration (RSOI) in Korea in the Spring of 2002, and again during exercise Ulchi Focus Lens (UFL) in Korea later in 2002.

This presentation will cover lessons learned in all of the exercise and experimental uses outlined above and discuss future plans for both applications. It will also discuss potential future areas involving the interoperability of C4ISR and M&S systems that could significantly improve the C2 decision process.

Operations Analysis Supporting the Joint Task Force

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As the Army transforms to the Objective Force, the Legacy Force continues to maintain its overmatch capabilities. Although the US Army Europe (USAREUR) is a key component of the Legacy Force, it also understands that it must maintain trained and ready forces capable of conducting military operations over the entire spectrum. As the USAREUR Headquarters transitions into an Army Service Component Command (SCC) and increases involvement in Joint and Combined operations, the focus of the Operations Research / Systems Analysis (ORSA) Cell shifts from supporting Base Operations (BASOPS) analysis to supporting the Warfighter. This change in focus requires the operations research community to re-look analytical support provided to the operational and tactical levels of command. The US European Command (EUCOM) took steps in this revolution by providing Operation Analysis (OA) Teams to Joint Task Forces (JTF) in the European Theater starting in 1997. This capability is now official and part of the EUCOM Directive 55-11. This document ensures that each JTF has the required analytical resources to plan for and execute its mission successfully. Similarly, the North Atlantic Treaty Organization (NATO) established an Exploratory Team to examine the Operations Analysis support to the Joint Task Force and Component Commanders.

This paper focuses on the capabilities and products that the OA team brings to the commander. The platform to demonstrate the utility of the team is a series of AGILE LION exercises featuring a Southern European Task Force (SETAF) led JTF deploying into Africa for a SSC and our support to an Air Force lead JTF. The authors will demonstrate products already developed and their impact on the success of the mission. Additionally, they will also offer their experiences and propose suggestions about how the OA team can integrate themselves as a key part of the JTF staff.

Analyzing Anti-Terrorist Tactical Effectiveness for Force Protection using X3D Graphics and Agent Based Simulation

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U.S. Naval Forces are increasingly the target of terrorist attack. There is a strong need to provide emerging technologies to forces afloat for analysis and visualization of tactical posture when defending warships in port. The SAVAGE research group in the Modeling, Virtual Environments and Simulation (MOVES) Institute at the Naval Postgraduate School (NPS) is building a large public-domain library of models and prototyping tools. We construct tactically interesting virtual environments using Extensible 3D (X3D) graphics, providing interactive displays either in standalone mode or via the Web. A sophisticated series of interactive Web-based 3D scenarios utilize geo-referenced terrain, humanoid avatars, physically based models and networked agent-based simulation. For example, a sophisticated scenario for U.S. Marine amphibious assault shows key spatial relationships that can easily be overlooked if solely analyzing in a 2D context. This presentation shows technical results representing conflicts between friendly and hostile assets, simulating complex ship-level Anti-terrorism and Force Protection (ATFP) measures. Specifically, we've built an agent-capable 3D reconstruction of the small-boat terrorist attack carried out by Al Qaeda against the USS COLE in October 2000 at Aden Harbor Yemen. These integrated models enable simulation, experimentation, visualization and statistical assessment for discovering potential shortcomings in force protection. A software-agent architecture capturing a variety of friendly and hostile representations is used to explore basic interactions, unforeseen threat combinations and even sensitivity analysis regarding skills, training and

personality traits of defending personnel. New applications of statistical analysis are possible using this methodology. Typically, outputs of interest include sequential-statistic means and standard deviations for various tactical measures of effectiveness (MOEs). For self-defense preparations, however, outlier scenarios that reveal unexpected tactical vulnerability provide new and critically important analytic outputs. The ability to plan, replay, analyze and replan realistic scenarios makes this approach valuable for both training and self defense. In closing, we examine next steps for scaling models, simulations and statistics to battle-group and theatre-level scenarios of tactical interest.

Analytical Support to Exercises for the Warrior Preparation Center

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The Warrior Preparation Center (WPC) is a fully functional wargaming center providing operational-level training and exercises to US and NATO staffs worldwide. The Analysis Directorate of the WPC provides analytical support to these exercises to help the training audience determine how well they are meeting their training objectives. This is usually conducted through the process of an After Action Review (AAR). The purpose of this presentation is to describe the techniques used by the WPC analyst to help demonstrate progress or to determine whether or not training objectives are being met. Topics discussed will include techniques on how to quantify subjective evaluations, trend line analysis, and the development of database tools to help collect AAR information. The presentation will also discuss how the WPC analyst improves the quality of an exercise by participating in the planning process. It will demonstrate how some basic analysis identifies potential "holes" in an exercise scenario or identifies areas which require more planning before the execution of an exercise.

Training Impact Analysis of the Global Combat Support System-Army Phase I: Military Occupational Specialty (MOS) 92A

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A training analysis was conducted to identify ways to improve current training for the Army's Military Occupational Series (MOS) 92A (automated logistics specialist), for which persistent training problems and substantial training requirements have been documented, and to reduce training problems for the future Global Combat Support System-Army, for which the MOS 92 is the primary operator. The analytical approach was to identify tasks critical to unit performance, identify tasks that should have the highest priority for advanced individual training (AIT), and to document training requirements of soldiers as they transition to new assignments. A study team conducted a three-tiered structured training priority assessment with unit supervisors and managers at 56 sites that represented the several different types of units to which MOS 92A soldiers are assigned. Soldiers on their second or later duty assignments provided data on new assignment training requirements. The study found that all of the tasks trained in AIT, plus some additional tasks, are critical to at least some of the units. Except for basic supply tasks, there was little agreement among units regarding the tasks that should have the highest priority for AIT. There were few skill and training requirements common across the different types of units, which present a difficult training challenge for the MOS 92A.

Just In Time Teaching

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This presentation focuses on the feasibility and the effectiveness of web-based Just In Time Teaching (JITT) in Air Force Professional Military Education (PME). No two students are at the same cognitive level; therefore some students require more attention than others. Currently, PME instructors have no way to anticipate student comprehension of the material.

This determination is necessary to enable instructors to tailor informal lectures, guided discussions, and case studies to maximize in-class time and help students achieve higher levels of cognitive learning. JiTT extends instructor contact time via cyberspace, allowing students to work in two interactive instructional environments: the first being the in-class seminar time, and the second being a web-based setting that can actually evolve as the class progresses and students' levels of understanding are determined.

Assessing the Impact of New Technology on Student Performance

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The Air Education and Training Command Studies and Analysis Squadron Technology Innovation Flight (AETC SAS/IT) conducts proof of concept studies on the effectiveness of innovative technologies. The purpose of this study is to ask some critical questions about the connection between new technology for training and education and how it impacts student performance. Specifically, does new technology typically raise student grades; does new technology typically raise other measures of student performance; are some technologies more successful than others; under what conditions does student performance go up or down? Study design involves comparison between classes with the new technology versus classes without. This paper attempts to find out why AETC SAS/IT studies consistently report lower student grades after new technology is inserted into training curriculum. The paper concludes with an analysis of why this study varies from others, followed by detailed recommendations for measuring the impact of new technology on student performance in the future.

Automated Administration for Education and Training

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The purpose of this presentation is to bring together three cutting-edge technologies into the education and training domain. This presentation will focus on three distinctly different studies to measure the effectiveness of automating curriculum development and delivery, and it is composed of three parts: Electronic Classroom, Thin Client, and Virtual Private Network (VPN). Electronic Classroom evaluated the effectiveness of Electronic Classroom (EC) technology on student comprehension and the potential for improved quality of training and reduced training costs through automating the test administration process. Thin Client will evaluate an innovative application of Thin Client technology as an alternative to conventional client desktop PC/LAN systems. VPN will study feasibility and effectiveness Reserve Officer Training Corps individuals accessing accessing academic records via .mil and .gov Internet sites from remote locations. This presentation will conclude with a discussion about the cost analysis associated with studying the reliability and maintainability of these technologies.

Portable Training Devices

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This presentation describes studies that measured the effectiveness of two portable training devices, Brainchild and Electronic Books (E-Books). The first study tests the hypothesis that Brainchild's portability and intuitive interface stimulates learning and decreases student washbacks and attrition. Brainchild is a handheld palm computer with a simple question and answer format that enables students to review course materials and prepare for tests. The second study concerns the suitability and effectiveness of E-Books as a replacement for printed course materials. This presentation concludes with a discussion of measurement results and analytic lessons learned.

Enhancing DoD Training for Smaller Scale Contingencies

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This presentation summarizes a recent Institute for Defense Analyses self-initiated Central Research Project that examined the current state of training involving civilian and military participants engaged in preparing for future Smaller Scale Contingency (SSC) operations. Recognizing the U.S. military forces deploying into SSCs will encounter and need to coordinate with civilian agencies of several types, U.S. joint and Service training organizations, including the unified combatant commands, have sought opportunities to engage with them in a training environment. For a variety of reasons (non-availability of personnel, costs, lack of effective planning, and others), attempts at such coordinated training have had mixed results. The research for this task included as key elements a series of interviews with civilian and military contacts and a questionnaire sent to a wider audience, eliciting useful responses from both communities. The research concluded that both communities—civilian and military—recognize the value of such prior training, but acknowledge that there are impediments to its effective execution. The study recommends actions to improve the military-civilian training interface, and suggests that additional research on this topic could be highly productive.

Dynamic Interface Modeling and Simulation System (DIMSS): Just How Good Is It?

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The "Dynamic Interface" issue between ship and helicopter is one the Joint Shipboard Helicopter Integration Process (JSHIP) was tasked to answer. JSHIP's response: the Dynamic Interface Modeling and Simulation System (DIMSS). DIMSS integrated existing models to create a high-fidelity shipboard/helicopter simulation—specifically, the combination of a UH-60A and a Navy Amphibious Assault Ship (LHA). Limited by test data, DIMSS sought to validate the simulation for training applications. An analysis of variance (ANOVA) approach was used. An accreditation board convened to examine the results and evaluate the fidelity and utility of DIMSS. This presentation focuses on the analysis and potential training scenarios.

While expanding the operational envelope of helicopters interfacing with Navy ships is necessary to provide the Joint Force Commander with the greatest flexibility in executing the mission, it is equally important for Army and Air Force units to be ready to go to sea when the need arises. This readiness requires a certain level of qualification and currency to land onboard the pitching and rolling ship deck. Until recently, maintaining currency required the pilot to periodically bounce a ship deck. This was not possible given the limited availability of ships for deck landing qualifications (DLQs). With recent changes in the multi-service memorandum of understanding for shipboard landing requirements, simulation can now be used to satisfy some of the initial qualification requirements (Field Deck Landing Practice) and extend the currency of the pilot up to two years from initial qualification. The acceptance of simulation for DLQ currency extension is partially due to the capabilities of shipboard simulation demonstrated by DIMSS at the NASA Ames Vertical Motion Simulator. Since DIMSS replicates the workload experienced by the pilot in the shipboard environment, it is perfectly suited for providing pilots with the experience of shipboard landings without actually going to sea. With DIMSS, pilots are not only learning the procedures for landing on a ship, they can become proficient in landing onboard a ship. DIMSS models and subsystems will be integrated into a UH-60 SFTS for the 101st Airborne Division to serve as a test-bed for enhancing shipboard simulation.

Using Analytical Simulations to Improve Performance of the Warfighter's Simulation

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The robustness of training simulations continues to skyrocket as the power of computers drastically increases in accordance with Moore's Law. Without being careful though, extra burdens demanded by trainers in behavior and fidelity will slow execution times to an unacceptable level. Computer-based simulations, such as the WARfighters' SIMulation (WARSIM), represent systems and forces built from a complex and functional description of military land warfare. The computerized battlespace that WARSIM model for training joint, corps and divisional commanders and their staffs can

become unwieldy in size and functionality. Functionality is key, but next comes performance of the simulation as it portrays combat and its related behaviors, environments and functions. One must assess the performance of the large-scale simulation to determine and justify the appropriate suite of fielded hardware, software and network. Logistical support personnel and training site coordinators need to know whether newly-built and equipped simulation centers will adequately handle the size of a specific training scenario. Proactive efforts to analyze and predict the processes and associated impacts on performance are critical. Using a performance prediction model, the analytical results may help reduce time, resources, and risks associated with the processes of the training system being acquired. The WARSIM Performance Emulation Model shows and predicts how a training simulation will perform. The results from the findings help guide the development of the actual WARSIM system components. This paper describes the use of a commercial off-the-shelf simulation package to emulate WARSIM and discusses the potential application to other simulation models for applying analytical tools that predict performance.

Potential applications of JWARS to Staff Training Support

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The JWARS land, maritime, and air forces are represented at a level of detail that has not been attempted before in Theater-level models. This rich set of detail coupled with fast run times provides an excellent vehicle for supporting high-level staff training in joint operations in both combat and non-combat scenarios. In particular, JWARS could potentially provide support to staff training exercises in several areas where significant challenges currently exist. This paper describes the upcoming release of JWARS and the potential application of JWARS to several training challenges. Specifically, it addresses how to: Use the Joint Data Support (JDS) Center for common baseline data, Build a joint Road to War, Increase the breadth of joint operations during single component exercises, Build automated plans and significantly reduce requirements for human operators, Conduct rapid time advances in simulation time between training system scenarios, Support seminar wargames of great scope and length on relatively small computers. Modifications in JWARS runtime environment will be required for some of the applications described above, but others could be conducted with only significant changes in the data used. This presentation makes these distinctions and describes the effort required and the opportunities available to support training beyond the current JWARS analytical scope.

Task Analysis Through the Warrior Level: Optimizing Training to Achieve Mission Success

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At the Joint Unified Command level, the Joint Training System outlines a requirements-based approach to training. The closed-loop, four-phase system outlines a structured methodology to define requirements and based on observable training, assess organizational competence for mission accomplishment, the pillar of Readiness.

Using extensive Mission analysis, strategic and operational objectives have been well defined at the CINC, Component, and Service levels, but definition of desired and expected outcomes of training is much less clear at lower echelons of the force structure. Moreover, there is no clear traceability of task behaviors at these lower levels of military activity to the higher order requirements. This is especially true when one examines task completion at the individual or "shooter" level of military operations. The readiness implications of this deficiency are great. A CINC or major commander has no objective way to accurately determine that training activities provided personnel currently under his or her command are adequate to ensure efficient attainment of strategic or subordinate task goals.

To rectify this analysis deficiency, a task model that decomposes higher order requirements to "shooter" level tasks and establishes behaviorally definable task outcomes, is required. Using the structured task model in analysis enables Commanders to accurately determine the need for, and desired outcomes of, specific training activities as related to CINC/Component/Service objectives and as defined by Mission Essential Tasks for each level of operational activity.

This paper uses the task decomposition paradigm of Mission-to-Operation-to-Task to discuss how performance at the individual level enables or constrains the CINC's ability to accomplish the assigned missions. It establishes how task definition that is directly related to higher order requirements) provide traceability, and thus accountability, for task completion at every level of operations. It demonstrates how training can be rationalized to support the (changing) needs of operational commanders. Finally, this paper will outline the structured approach by which "distributed" mission and task analysis contributes to more effective use of scarce resources to achieve required readiness levels.

Analytic Support to Training WG-22

Assessing Decision Making Skills in Virtual Urban Environments

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Leaders of small dismounted infantry units will face growing responsibilities and increasing challenges in combined arms combat and in contingency operations in the urbanized battlefield of the future. Training for MOUT is limited by time, cost, and safety factors. Virtual environment technologies have the potential to provide the Army with a training and assessment capability to meet these new demands.

In the SBIR Phase I Virtual Soldier Skills Assessment (ViSSA) Project, ScenPro, Inc. performed research for the development of an automated training assessment and after-action review support tool to assist trainers with mission rehearsal of dismounted forces for Special Operations and Contingency Operations using virtual urban environments. The ViSSA system is currently in Phase II development, tracking mission-related factors linked to soldier decisions, movements, fires, contact with virtual entities, and time factors under an intricate web of overlays designed to capture, analyze, and store these specific pieces of data during a virtual training exercise. The result is a training and assessment system that can accurately monitor soldier performance and quickly summarize leadership strengths and weaknesses across key performance dimensions.

The information assists the trainer in conducting an effective after-action review by providing the rapid replay of events, summary statistics, Socratic questions, and top-down snap shot views of the simulation at critical decision points during the virtual training exercise to support leadership performance evaluations.

Battlefield Performance, Casualty Sustainment & Medical Planning

WG-23

Chair: James Mantock, ScenPro
Co-chairs: LT William Deniston, SSC-SD
Michael Gately, ScenPro
James Zouris, NHRC
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Common User Database Development

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One key to good models is good data input into the model. We are working on developing a database that will provided data for input into models for patient care and movement within the theater. The Common User Database starts with a Patient Condition and breaks it down into one or more medical conditions. Each of these medical conditions will be associated with the tasks to be performed. The next step is to assign a set of tasks to each medical condition. Each task will be associated with the equipment and supplies, in generic terms) required to perform the task.

Personnel at the Army Medical Department Center and School (AMEDDC&S) are developing a prototype database structure based on input from tri-service representatives and personnel from the Joint Readiness Clinical Advisory Board (JRCAB). It has not been determined who will develop the final database.

Stress Casualty Forecasting

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Impact of Small Work Teams on Combat Care & Emergency Care Performance

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The MedTeams Program is a DoD research initiative that establishes small clinical work teams composed of physicians, nurses, and technicians and evaluates the power of this reengineering to reduce clinical errors and improve the efficiency of emergency and combat care delivery in both field hospitals and fixed facilities. The teamwork principles are drawn from

research on military and civilian aircrews. The project has evaluated the positive impacts of employing these teams and teaching teamwork skills to clinicians. The training has also proven valuable in improving the job performance of non-medical support personnel in field medical units. Simulation facilities that employ the use of patient simulators are being set up so that high-risk clinical care conditions can be simulated and difficult teamwork can be exercised without risks to patients. Future proposed efforts include 1) capturing team performance data from the simulator environment training exercises to support organization-level modeling efforts and 2) modification of team training curriculum to support rapid, large-scale train up of teamwork skills in homeland defense groups that must respond to terrorist events.

Exploring the Validation of Lanchester Equations for the Battle of Kursk

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This research explores the validation of Lanchester equations as models of the attrition process for the Battle of Kursk in World War II. The methodology and results of this study extend previous validation efforts undertaken since the development of the Ardennes Campaign Simulation Data Base (ACSDB) in 1989 and the Kursk Data Base (KDB) in 1996. The KDB is a computerized database developed by the Dupuy Institute and the Center for Army Analysis from military archives in Germany and Russia. The data are two-sided, time-phased (daily), highly detailed, and encompass 15 days of the campaign. This work examines how the various derivatives of Lanchester's equations fit the newly compiled database on the Battle of Kursk. In addition, the effect of using purely engaged forces, in contact forces, and all forces in parameter estimation is examined.

Predicting Battle Outcomes With Classification Trees

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What factors are associated with victory in combat? To look at this question, this talk applies classification and regression trees (CART) to the CDB90G land combat data set. This data was developed the Center for Army Analysis (CAA) and contains about 140 attributes on nearly 660 land battles. The classification trees reveal that objective variables, by themselves, cannot explain the outcome of battles. Relative factors, such as leadership, have deep impacts on success. The classification model predictions on test sets reveal correct classification rates as high as 79 percent. Considering the variability in the data set, this outcome is satisfying. Classification models also reveal that the factors affecting the outcome of battles have changed over time. A leadership advantage played an important role for hundreds of years. However, in the 20th century, air sorties, tanks, and intelligence showed a higher importance.

Reducing Non-monotonicities in Combat Models

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Non-monotonic behavior in combat models is an important topic to those using the output of such models as a basis for decision-making. These decisions can be complicated by non-monotonic behavior in the combat models. This research examines the Dewar model, which exhibits non-monotonic behavior caused by the chaos inherent in its structure. The dozen or so previous papers on this model have examined only small subsets of this 18 dimensional combat model. The combinatorial possibilities of main effects and interactions among the 18 dimensions are too great to examine en masse. Consequently, we use some advanced statistics to explore the model with three primary goals. First, systematically explore the Dewar model for additional non-monotonic behavior. Second, determine the effect of stochastic modeling on the non-monotonic behavior of the Dewar model response surface. Third, develop a method for measuring non-monotonicity in the response surface generated by the model.

Casualty Estimation for Medical Planning for an NBC Environment

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The U.S. Army Office of the Surgeon General (OTSG) is the NATO Custodian for Allied Medical Publication 8, Medical Planning Guide for the Estimation of NBC Battle Casualties. Over several years, OTSG, with the advice and assistance of NATO medical experts, developed three volumes, one each for nuclear, biological, and chemical weapons. All three volumes were ratified by the NATO NBC Medical Working Group in February, 2001. Beginning in 1999, OTSG directed the development of the medical Nuclear, Biological, and Chemical (NBC) Casualty and Resource Estimation Support Tool (CREST) as a deliberate medical planning capability for an NBC environment. The NBC CREST software application estimates NBC casualties based on the methodology of Allied Medical Publication 8. In addition, NBC CREST provides map-based scenario generation, medical resource estimation based on treatment protocols from the Joint Readiness Clinical Advisory Board, and coarse-of-action analysis based on Tables of Organization and Equipment for generic battlefield medical treatment facilities (MTFs) of the U.S. Army. The casualty estimation methodology relies in part on the estimation of individual performance degradation caused by exposure to NBC agents.

Behavioral Impacts on Battlefield Performance in JWARS

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In the JWARS theater-level analytical model, units from countries with limited training, less combat experience, or poor leadership can be made to perform at lower levels of effectiveness than units from countries that have significantly better training, extensive combat experience, and good leadership. Within a particular country's forces, additional distinctions can be made among elite, standard, and substandard units and between functionally different units (combat, combat support, and combat service support). Less capable units also suffer greater attrition and rout or surrender earlier (depending on several other factors). To support this representation, the National Ground Intelligence Center (NGIC) has rated foreign ground forces according to a set of characteristics related to combat performance. JWARS has applied this concept of "soft factors" to JWARS land forces. Currently, soft factors directly affect six unit performance characteristics: breakpoints, rate of direct fire, degree and length of unit suppression, speed of maneuver, and time to don MOPP gear. This presentation is the next in a series of reports on the development of soft factors in JWARS, and it provides information on installations and facilities with respect to defining the work they do (unit performance characteristics) and a unit's effectiveness with and without soft factors considered. It also discusses the direction JWARS is going with respect to the interaction of soft factors with other "soft" elements represented in JWARS such as unit effectiveness due to significant numbers of wounded, contaminated, or otherwise incapacitated personnel.

BioTerrorism Planning: San Antonio Lessons for Success

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Real-Time Predictive Medical Data Fusion Watchboard

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Assessing Decision-making Skills in Virtual Urban Environments

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Members of small dismounted infantry units will face growing responsibilities and increasing challenges in combined arms combat and in contingency operations in the urbanized battlefield of the future. Training for MOUT is limited by time, cost, and safety factors. Virtual environment technologies have the potential to provide the Army with a training and assessment capability to meet these new demands.

In the SBIR Phase I Virtual Soldier Skills Assessment (ViSSA) Project, ScenPro, Inc. performed research for the development of an automated training assessment and after-action review support tool to assist trainers with mission rehearsal of dismounted forces for Special Operations and Contingency Operations using virtual urban environments. The ViSSA system is currently in Phase II development, tracking mission-related factors linked to soldier decisions, movements, fires, contact with virtual entities, and time factors under an intricate web of overlays designed to capture, analyze, and store these specific pieces of data during a virtual training exercise. The result is a training and assessment system that can predict battlefield performance and quickly summarize soldier strengths and weaknesses across key performance dimensions.

The information assists the trainer in conducting an effective after-action review by providing the rapid replay of events, summary statistics, Socratic questions, and top-down snap shot views of the simulation at critical decision points during the virtual training exercise to support performance evaluations.

NBC Medical Resource Estimation and Course of Action Analysis

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The Nuclear, Biological, and Chemical Casualty Resource Estimation Support Tool (NBC CREST) supports deliberate medical planning in an iterative, integrated process for US Army medical planning at the Corps, Division, and Corps Medical Brigade levels. The Resource Requirements Estimator (RRE) module of NBC CREST provides a quick logistical estimate of medical requirements in the NBC environment based on the potential for casualties. RRE estimates include weight, volume, and time-phase resource requirements over the duration of treatment. The Course of Action Analysis (COAA) module provides a time-phased estimate of the critical medical resources required for patient treatment compared to the capability of deployed medical resources to meet the demand. Graphical displays provide a high level assessment of critical NBC medical resource sufficiency based on the Class VIII Materiel, Personnel, Evacuation Assets, and Beds available at each level of care in the user-defined medical support network. Depending on the required level of resource satisfaction and detail required, the user may drill-drown and iteratively modify existing deployed medical resources down to the unit level to resolve potential resource shortfalls, or evaluate the benefits of additional medical support during the planning stages of a mission. Subsequent analyses will show how well the new medical Course Of Action resource set satisfies the requirements. The NBC CREST is currently being developed in conjunction with the Army Office of the Surgeon General (OTSG).

Measures of Effectiveness WG-24

Chair: MAJ Barry C. Ezell, USMA
Co-chairs: Adam B. Siegel, Senior, Northrop Grumman Analysis Center
Bill Owen, Logistics Management Institute
Advisor: Sue Romans, CALIBRE Systems, Inc.
GIF 152

The following abstracts are listed in alphabetical order by principal author.

Addressing the Cost and Value of C4I Information in AOAs

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The nature of major Air Force system acquisitions is substantially changing. The systems themselves are much more information dependent, and many Analyses of Alternatives (AoAs) for these acquisition systems must address a trade of money spent on information vs. money spent on warhead. This presentation will focus upon several significant steps the Air Force has taken to improve how it analyses the value of information in AoAs, some still needed improvements, and some problem areas as we continue to adapt the AoA process for C4I systems. The specific areas of discussion include how to cost C4I support to weapon system and how to measure the value of C4I in pre-warfare environment.

JWARS: The Assessment Process (V&V, T&E)

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The Joint Warfare System (JWARS) will be a state-of-the-art, constructive simulation that shall provide a multi-sided and balanced representation of joint theater warfare. Users of JWARS will include the CINCs, Joint Task Force (JTF) Commanders/Staff, Services, Joint Staff, Office of the Secretary of Defense (OSD), and other DoD organizations. JWARS will be capable of performing Courses of Action and Force Sufficiency analyses at IOC, and will be able to perform System Effectiveness and Trade-off analysis and Concept and Doctrine Development at FOC.

This presentation will provide insight into the assessment process of JWARS. The assessment process includes both Verification & Validation (V&V) and Test and Evaluation (T&E) which are outlined in the JWARS V&V Plan and JWARS Test and Evaluation Plan (TEP). The V&V Plan, as required by the JWARS ORD, follows the guidance outlined in the DoD VV&A Recommended Practices Guide (RPG), modified, where appropriate, for the JWARS V&V effort. The T&E Plan, as also required by the JWARS ORD, follows the guidance outlined in the DoD 5000.1 and 5000.2 acquisition documents for ACAT III level programs and Automated Information Systems (AISs), modified, where appropriate, for the JWARS T&E effort. The Joint Analytic Model Improvement Program (JAMIP) is the proponent of the JWARS model. The associated JAMIP Executive Committee (EXCOM) and Steering Committee (SC) are the associated approval authorities for the V&V process and T&E process. This presentation will discuss the importance of the assessment process, user interface, verification and validation activities, test and evaluation activities, documentation procedures and reporting criteria. The V&V as well as the T&E processes encompass the internal JWARS office efforts as well as the V&V agent and Operational Test Agencies interface with the user and test community.

A Skills Catalogue for Workforce and Succession Planning

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Measures of Effectiveness WG-24

The Workforce Transition Model: A Decision Support Tool for Human Resources Managers

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A Warfighting/Materiel Structure for Weapons Evaluation

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For a number of years, we have been developing an analytical structure suitable for weapons analysis. Originally, it was focused narrowly on single-platform, ballistic live-fire analysis. More recently, we have generalized the structure for systems of systems. Test and Evaluation (and the activities and processes that support it) is just one of many focus areas that are amenable to the data structures, operators, order of instantiation, and process sharing that this framework exhibits.

From an overarching perspective, one can argue that the Army's acquisition business derives from a panoply of military missions underwritten by materiel. If that is true, one can divide the problem into two indirectly connected pieces. Part One is to define the mission in terms of its (generally abstract) objectives and then, through a mission-to-strategy-to-task (decompositional) process, develop and define the sequence of tasks (order, context [e.g., site, time, weather], and standards [e.g., how quickly, how error-free]) which if so performed will accomplish the mission objectives. Part Two of the problem is to define/assign the appropriate materiel requisite to the execution of the defined tasks.

To refine the argument, a data structure exists within Part One consisting mostly of mission Measures-of-Effectiveness (MOEs). The MOEs may originate at the National Command Level (or lower) and can be decomposed to the required level of detail. At each of the sub-levels within this major category, each MOE either points to a subordinate MOE or terminates in a supporting task(s). It is these task termination nodes that specify what materiel needs to accomplish.

Part Two of the structure involves the actual materiel; this category is populated by the component pieces that constitute the various platforms. However, at this point the two structures are not linked and, in fact, are not compatible. Part One defines what tasks need be accomplished. Part Two defines what material is available. To form a link, the component pieces must be integrated into a system of systems and mapped to aggregate capabilities, metrics that are compatible with task requirements.

The final element is recognizing that the individual component pieces of Part Two don't necessarily perform in an unchanging fashion. Through the processes of mission execution, parts will be used up, worn out, and broken, as well as receive ballistic and other classes of damage from the OPFOR that further degrade the state of components. Provision must be made to admit state changes to components (as defined by the mission profile).

In summary, this structure defines a series of connected metrics starting with highest-level mission MoEs and then leading to tasks. The tasks are then related to aggregate materiel capabilities, next to the supporting component pieces, and finally to the robustness of those pieces susceptible to state changes, both "negative" (e.g., ballistic damage) and "positive" (e.g., fuel resupply). In this structure, the highest-level MoEs are the primary metrics. All of the subsequent metrics are derivative, including capability-based performance. Generally the lower-level, derivative metrics are measurable while many of the higher-level metrics are not.

This structure makes possible the assignment of benefits, both primary and derivative. It also can account for costs, both those traceable to the direct purchase of material as well as to the execution of activities defined by mission-based tasks (in the spirit of activity-based costing).

In this paper, we describe this structure, review the primary and derivative metrics, and discuss which metrics are observable or only knowable via inference. We will discuss how this structure contributes to the prosecution of the T&E process, the universe of measurable and nonmeasurable metrics, how the classes of metrics are linked, and how value as well as costs can be ascribed within this context in order to support cost/benefit analyses.

Measures of Effectiveness WG-24

Objective Force Concept Exploration, A Notional Combat Battalion Engagement

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This study supports Objective Force Combat Battalion concept development and the Army Transformation. It focused on developing, examining, and refining Combat Battalion concepts, and supporting the Future Combat System (FCS) Mission Needs Analysis.

The study scenario facilitates analysis of the Objective Force in combat operations. The scenario provides a context in which an Objective Force Combat Battalion conducts offensive operations in 2015 against a technologically advanced Red force. The engagement was explicitly modeled using the Interactive Distributed Engineering Evaluation and Analysis Simulation (IDEEAS) model. IDEEAS is an entity-based simulation, capable of force-on-force representations, that permits examination of concepts and parametric analysis at the engineering level of detail. Use of the notional battalion force structure allowed O&O concept exploration prior to force design decisions.

This study contributed substantially to the development of the Objective Force, especially with regard to the Unit of Action force design. In addition to the development of concepts, tactics, and insights for future operations the study provided a powerful visualization of this future force. The scenario and base case developed during this study were used extensively by the TRADOC Unit of Action Task Force in their subsequent refinement of the force design. These tools were also used by the Army Medical Department in its transformation wargame effort.

This presentation will provide an overview of the study scenario's purpose, methodology and results.

Towards a Theory of Measures of Effectiveness

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This paper makes the bold claim that an explicit theory for "measures of effectiveness" (MOEs as they are commonly referred to) does not exist. As a result several definitions for MOEs have been advanced, that while similar, do not provide the needed insight in to system performance evaluation. The earliest references to MOEs are found in Chapter 3 of "Methods of Operations Research" (Philip M. Morse and George E. Kimball, Peninsula Publishing, 1970, 1st edition, revised). Their description of MOEs is somewhat general but their concept of "constants" that define system performance is consistent with many approaches that followed.

Original studies performed by the Military Operations Research Society's (MORS) Command and Control workshop in the mid- 1980s laid a foundation for a more theoretical approach that was well received within the MORS community. However, little has been done in the last decade to further this work. Most papers in the latter part of the 1990s make no reference to the workshop reports and other published papers that resulted from the workshop.

The emphasis on systems-of-systems thinking and Network Centric Warfare concepts makes a coherent theory of MOEs a necessity. The inability to clearly articulate C2 MOEs has contributed to the current interoperability problems faced by the Navy.

This paper will present a review of the original work performed by MORS as well as relevant material that has been published in the intervening years.

It will extend the original body of work using the systems-of-systems perspective originally developed by Russell Ackoff. A concise systems based definition of MOEs will be derived using this framework. The paper will also present the framework for a consistent mathematical theory for MOEs.

This paper will present a paradigm for MOEs that is grounded in systems theory. The result will be a consistent approach that provides a basis for developing testable MOEs within a mathematical framework that allows for evaluating the statistical significance of change when performing analysis of alternatives.

Bounding Situational Awareness

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Measures of Effectiveness WG-24

Situational awareness is a commonly used but ill-defined idea that is applied to the execution of tactics and strategy. The traditional method of evaluating situational awareness is by attrition. While it is not easy to describe the conditions necessary for good situational awareness, it is possible to identify some conditions of poor situational awareness.

While useful in focused applications, traditional approaches have lacked both formality and comprehensiveness. It is easy to provide a measure of situational awareness when there are absolute right and wrong actions, but difficult when the term is applied at the tactical or strategic level. Degree of success, interpretation of condition, and utilization of resources, are some factors that are considered in the informal estimation of situational awareness. Even these factors are relative, not absolute in nature. The game of Klondike solitaire has an absolute measurement of success, namely the number of cards moved from the tableau to the foundations. For a given shuffling of the cards it may not be possible to move all cards to the tableau; the situational awareness of the solitaire player should be gauged against the maximum achievable score for the situation, not the maximum theoretical score. To add even more complexity to a relatively simple example, Klondike solitaire is an imperfect knowledge game. The player's decisions are based on knowledge that represents a subset of the total state of the game. Thus the player's situational awareness is not only a function of what is know and what can be know, but also of the player's understanding of what can and cannot be known. An evaluation of situational awareness must be based upon an understanding of the relationship between the reality of the situation and the perception of the situation.

This paper provides a general framework for formally defining Situational Awareness and its component metrics and instantiating them for real world situations. Methods are presented for applying the general definitions to specific situations and producing a usable data collection and analysis plan for the evaluation of Situational Awareness for many problems. Consistency across many domains of application is one of the key features of this approach. It is heartening to see that traditional approaches can be expressed as special cases of this general theory, and new approaches can be used with legacy systems.

Quality of Positional Information

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Elliptical estimations of position are significantly more complex to evaluate than circular or point estimates. The geometry of the ellipse makes more conventional measures of the quality and inappropriate. Conventional measures may produce misleading data that can vary significantly depending on the order in which the test data are analyzed. To avoid these pitfalls, the measures of effectiveness for elliptical estimations of position should be based on elliptical geometry.

While the theory for evaluating ellipses is more complex, the measures of effectiveness themselves are relatively simple and yield unambiguous and robust results. In the vast majority of cases, the quality of containment of a contact for an ellipse can be measured by the K value:

$$K = 1 - r/d$$

Usefulness may be evaluated as the measure of the effort required to locate a contact within the ellipse, the minimum search area, the Quality-Area product:

$$QA = \frac{r^2 A}{d^2}$$

Both of these measures can be calculated from only the known characteristics of the ellipse and the corresponding true position of the contact.

Other, more complex evaluations of the elliptical estimation of position are offered in this paper for cases when the technical requirements of the test are commensurately more complex. These other measures of effectiveness grow in complexity with requirements of the problem. They provide a more advanced perspective on quality and usefulness, and serve to illustrate the context of the workhorse measures, the K value and the Quality-Area product. As technology advances and automated systems are capable of solving problems considered too difficult or too time consuming for traditional evaluation, and as integrated, multi-platform systems create solutions of greater complexity, the need for these advanced measures of effectiveness will increase.

Measures of Effectiveness WG-24

Joint Global Positioning System Combat Effectiveness (JGPSCE) Joint Test and Evaluation (JT&E)

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On 29 July 1999, the Office of the Secretary of Defense (OSD), Deputy Director, Developmental Test and Evaluation (DD,DT&E), Strategic and Tactical Systems (S&TS), in cooperation with the Joint Chiefs of Staff and the Services, chartered the JGPSCE Joint Test. Over a four-year period, the JGPSCE JT is conducting a series of test events that focus on joint operations where the Global Positioning System (GPS) is denied or degraded by hostile electronic warfare (EW) or friendly electromagnetic interference (EMI). Specifically, the JGPSCE JT is addressing the following issues:

Issue 1: What is the impact of GPS vulnerabilities on the effectiveness of joint operational missions that require precision engagement?

Issue 2: What changes in joint tactics, techniques, and procedures (TTPs) or system-level mitigation techniques improve or maintain joint operational mission effectiveness in the event of GPS EW and EMI?

Issue 3: What test methodologies can be employed to characterize GPS vulnerabilities in future acquisition and integration programs?

The JGPSCE JT conducted its second field-test -- GYPSY BRAVO Part 1 – from 9 through 25 Jan 02 at Naval Air Station Fallon Range Training Center. The focus of the second test was to assess the impact of EW and EMI on a selected set of weapon systems including precision guided munitions. This presentation will highlight the JGPSCE test concept, methodology, and preliminary results.

TRACER/FSCS Combined Analysis

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During the last two years, a combined UK/US operational analysis working group conducted the Tactical Reconnaissance Armoured Combat Equipment Requirement (TRACER)/Future Scout Cavalry System (FSCS) analysis leading up to the February 2001 Affordability Review held in London. This presentation will show the study approach, highlight the initiatives in new Measures of Performance (MOP) and Measures of Effectiveness (MOE) used by the two countries, note the challenges and successes of a combined analysis and present the analysis results. Included in the presentation will be:

- A brief review of the methods and tools used in the analysis, including the MOE and MOP, the models, and scenarios,
- The technical analysis and system performance approach and results.
- The operational effectiveness analysis results, highlighting the effects of innovative approaches to representing ground scout capabilities in combat models, and the insights gained from the work.
- The combined cost analysis approach and results.
- General conclusions and recommendations.
- Lessons learned regarding MOE and MOP that may apply to Future Combat System and Objective Force analysis.

The Use Of Design Of Experiment During Tactics Development

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The emergence of a new level of international terrorism, especially as a direct and significant threat to the security of the continental US, is a perfect illustration of a factor that will demand changes in military tactics, doctrine, and weaponry. We should expect to see, therefore, changes in strategy, operational doctrine, tactics, and weapons over the near future. We may also see an increase in the funding for these endeavors. However, we can be sure that in any case, resources for testing will always be constrained. There will always be a need for efficient as well as effective testing.

The purpose of this study was to demonstrate the utility of DOE in the tactics development arena in order to dispel the myths that DOE is either impractical or ineffective. The study included both experimental design (for example, the use of factorial experiments, randomization, independent trials) and analysis (the use of ANOVA). The study utilized a Microsoft Excel-based simulation of aerial combat—a relatively simple, but nevertheless high fidelity model of aerial combat engagements involving as many as 8 versus 8 players, using notional but realistic event probabilities obtained from subject matter experts. The model includes such events as threat detection, hostile declaration, and effective missile employment. After a significant amount of verification using subject matter expertise, the model was given favorable reviews. We then set up a notional tactics development evaluation, with a number of control factors typical of TD&Es (threat electronic warfare, friendly support assets, threat tactics options, and friendly rules of engagement) to assess two notional friendly tactics (Option A and Option B). Our response variables included such typical air-to-air success measures as kill ratios, threats killed, and friendlies lost.

The result of this study is a method of demonstrating the utility of DOE during the most complex of tests, as the Air Force embarks on a program to make it the methodology of choice for all Air Force testing.

The Attrition Model

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The presenters designed, developed and now exercise an Attrition Model on behalf of senior management at the National Security Agency. The model is Markovian based, that was developed in the spring of 1996 to better understand and then forecast how the early-out and incentives offered to Agency civilian employees would affect attrition figures and help the Agency achieve its downsizing goals. The model has been in use consistently since 1996, with the presenters making significant enhancements, updates to accurately reflect changes in the Agency, and calibration of underlying transition figures over this time period. The model's accuracy has been fairly good when early-out and incentive programs offered to Agency civilians have remained constant.

The Attrition Model incorporates the Agency full-time civilian population to the entity level and uses historical attrition rates to project how many individuals will leave Agency service in a given time period. The model calculates regular and early retirement based on the attributes of age and years-of-service as these are the primary factors involved in an individual's retirement decision. Resignation, on the other hand, is tied more closely to an individual's skill field; therefore the model makes resignation projections based on occupational codes and age. The model is best used as a predictor of overall Agency attrition expectations, but has been use at lower level of analysis for organizations and groups.

The Attrition Model and its results will be presented.

Quantifying Utility based on GPS Performance Attribute Values

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The GPS Performance Attribute Analysis Tool (GPAAT) was developed to compute and analyze the military utility of various GPS performance attributes, such as availability, accuracy, integrity, and received signal power. This framework has been built to assist in the determination of GPSIII design specifications by calculating and analyzing the linkages between specific system Performance Attributes and operational Measures of Merit. GPAAT's construct is modeled around the complete "strategy-to-task" decomposition of Joint Vision 2020. GPS performance attribute values are used to calculate Measures of Performance (MOP), such as navigation error and CEP for use cases within the JV2020 decomposition. GPAAT provides traceability from MOPs to Measures of Utility (MOU), including Measures of Effectiveness (MOE) and Measures of Outcome (MOO). This tool determines performance-cost trades for military operations by analyzing the cause-effect relationship between performance attributes and cost. This analysis approach will enable military decision makers to quantify the benefits associated with improving specific performance attribute values. The presentation includes an outline of the tool structure and flow, a sample scenario of military use cases, and utility analysis.

Measures of Effectiveness WG-24

Measures of Effectiveness Applied to Joint Combat Identification

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Emerging requirements within DoD now challenge the newly designated Joint Combat Identification and Evaluation Team (JCIET) Command as it looks to plan future evaluations. These emerging requirements are (1) The conduct of CID evaluations within established joint exercises; and, (2) Evaluations of the Key Performance Parameters (KPPs) stated in the newly approved Combat Identification (CID) Capstone Requirements Document (CRD).

The JCIET Command serves as a joint activity under the command & control of the Joint Forces Command (JFCOM) to evaluate the joint mission area of Combat Identification (CID). The objective of Command participation in the 2002 Military Operations Research Society Symposium (MORSS) is to interact, through an information presentation, with the MORS community. This proposed interaction would focus on emerging requirements driving Measure of Effectiveness (MOE) refinements/developments for the Command. The scope of the presentation would be limited to the practical use of MOEs for root-cause analysis in evaluating the formal joint Mission Area of Combat Identification.

Root-cause analysis does not employ statistical techniques. The Command is largely limited to this method of analysis because of the employed method for collecting data. All data is collected during an evaluation conducted over a two-week period within a live, dynamic joint environment allowing the prosecution of free play operations. Collected data allows detailed mission reconstruction and supports rigorous analysis of evaluation objectives.

JCIET Operations are joint in nature and comprise joint task force resources. Such operations employ select land, sea and air weapons platforms, staffs and forces across all of the Services. These resources are "networked" with Command and Control (C2) and Intelligence, Surveillance and Reconnaissance (ISR) systems. ISR systems include all levels of conflict, i.e. National Technical Means (NTM), operational and tactical. "Networking" consists of existing or developmental tactical data networks.

The JCIET Command welcomes the opportunity to provide an information presentation to interested members of the MORSS community regarding refinements and use of established MOEs to assist root-cause analysis associated with these two emerging requirements.

Evolution of Statistical Electromagnetic (EM) Test, Analysis, and Assessment Techniques

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Quantifying the performance of systems during and after the occurrence of a high frequency EM event is difficult using conventional test, analysis and assessment techniques. Conventional EM test, analysis, and assessment techniques are deterministic and are ill suited for applications to problems containing large unmanageable uncertainties. It may be possible to determine the probability of survival or probability of failure of a system based on the results of testing conducted at levels below the threat.

Virtually all Navy systems are contained within some type of enclosure. The ability to predict the probability of upset to electronic equipment due to high levels of electromagnetic energy outside the enclosure, without having to conduct threat level testing is most desirable. This is especially true since some of the threats are still on the drawing board. The introduction of new systems and COTS items into the operational environment without adequate EM testing can (and has) resulted in serious problems. The ability to predict the potential for problems based on low-level type tests conducted on commercially available equipment should prove valuable in screening out potential problem equipments.

Statistical EM test, analysis, and assessment techniques have been successfully used to extract useful information from the measured fields in large enclosures such as reverberation chambers. Statistical models of the field quantities are a convenient and simple way of describing the uncertainty inherent in high frequency EM interactions. The knowledge of this uncertainty permits the design and implementation of practical test, analysis, and assessment techniques.

Course of Action Comparison in Coalition Humanitarian Assistance and Disaster Relief Missions

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Comparing courses of action or alternatives in order to make any decision is a non-trivial endeavor. However, when choosing among courses of action in coalition humanitarian assistance and disaster relief (HA/DR) missions, the process is extremely complex. Differences in doctrine, language, agenda, policy, level of contribution, ability, and other areas complicate the decision process so severely that it is necessary to delineate clearly a process that is understandable by all and that serves to unify, not divide, the coalition. This presentation shares the author's experience in facilitating the course of action comparison portion of a multi-national planning augmentation team (MPAT) crisis action planning exercise during a United States Pacific Command (USPACOM) training event in Seoul, Korea from 11-18 January 2002. Key to the course of action comparison process are determining what measures of effectiveness are appropriate, how the measures of effectiveness should be defined, how measures of effectiveness should be weighted, how the alternatives should be scored, and what the results mean. Finally, the strengths and weaknesses of this MPAT course of action experience are provided along with recommendations for improving the process.

Development of Countermeasure Performance Parameters to Address Terrorist Threats

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Abstract unavailable at printing.

Weapon Effects Analysis and Probability Software (WEAPS)

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WEAPS is an easy-to-use software package that calculates the effectiveness for many combinations of weapon/target/delivery aircraft/delivery profile/weather-state using Joint Munitions Effectiveness Manuals - Air-to-Surface (JMEM/AS) tri-service approved methods. For the targets, such as hardened bunkers, for which the JMEM/AS methods aren't appropriate, engineering level models are used to perform off-line calculations and the results directly loaded into the WEAPS database for inclusion into the calculated output. Aircraft attrition can also be output, but requires an externally generated database.

The WEAPS database covers inventory and non-inventory weapons and is under continual update and revision. The source for most inventory weapon data is the JMEM/AS Weaponeering System (JAWS). There are many sources for non-inventory weapon data, but they include the Air Force Research Laboratory Munitions Directorate.

The output data is most often used as an input for theater-level models such as the Combat Forces Assessment Model (CFAM), but can also be used as the basis for engagement-level (one-versus-one) analysis. The WEAPS predecessor, SABSEL, has been used for many studies, including Analysis of Alternatives, Quadrennial Defense Reviews and is a key tool in the annual Non-nuclear Consumables Annual Analysis (NCAA) process where the Air Force establishes weapon inventory requirements. Where SABSEL was only available to a select few organizations, WEAPS will be available to all DoD agencies and their contractors.

WEAPS is PC based and is being developed with Microsoft Visual C++. The WEAPS code is unclassified, but will use a classified database. The initial release of WEAPS is anticipated early summer 2002, with annual updates thereafter. A subscription is required to receive WEAPS, which will include an annual WEAPS User's Group meeting and training session.

Test and Evaluation WG-25

Chair: Chuck Walters, MITRE Corp
Co-Chairs: Dr **Frank B. Gray**, HQ AFOTEC,
Sharon Nichols, HQ AFOTEC
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Scott Shaw, Institute for Defense Analysis
Greg Hutto, Sverdrup Technologies Inc,
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The following abstracts are listed in alphabetical order by principal author.

A Decision Methodology of Modeling and Simulation in Operational Test and Evaluation

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Test and Evaluation plays an important role toward ensuring that war fighters have equipment that is operationally suitable and effective for intended use. Verified and validated modeling and simulation (M&S) is a recognized part of the Simulation, Test and Evaluation Process (STEP). Benefits of M&S in T&E - in terms of risk reduction, reduction in assets required for test, knowledge gained, and design of experiments - are appreciated, but can be difficult to quantify and monitor. In a climate of limited developmental resources, program managers may be reluctant to let budgetary decisions rely even in part on M&S predictions of system performance. This can be especially true if negative publicity arises on shortcomings that M&S was intended to detect for redesign prior to fabrication. The authors seek to identify a deliberate management method that affects the use of M&S in T&E. The authors will review selected programs that have used M&S. The authors will review the type of information needed to reach each acquisition milestone, identify how M&S was used throughout the program, critique and draw conclusions. Based upon these conclusions, the authors will offer a preliminary methodology and metrics for when to use M&S in T&E.

Analytic Test and Evaluation Management System (ATEMS)

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Major stresses are being placed on the Test and Evaluation (T&E) community. Advances in weapons technology require advanced and more complex T&E. Testing must also be more efficient to complete the same high quality evaluations with less manpower, a shorter schedule and reduced funding. Several programs are building advanced tools and developing new test processes to meet the increasing demands on the T&E community. They will provide software infrastructures, simulation environments, command and control visualizations, interoperable ranges, and more. Many of these tools are being developed with a focus on supporting actual or simulated test events or future weapons systems. TESTSIM, a T&E management system, targets support to the tester and the evaluator. It will provide knowledge-based, automated decision support for the entire DoD T&E process. Key capabilities will include automated support to Analysis of Alternatives, decisions on "readiness for OT", and analysis of interactions between the System Under Test (SUT) and its virtual or actual test environment. This paper will review the TESTSIM concept, how it supports the DoD acquisition model and T&E process, and the TESTSIM development strategy.

JWARS: The Assessment Process (V&V, T&E)

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The Joint Warfare System (JWARS) will be a state-of-the-art, constructive simulation that shall provide a multi-sided and balanced representation of joint theater warfare. Users of JWARS will include the CINCs, Joint Task Force (JTF) Commanders/Staff, Services, Joint Staff, Office of the Secretary of Defense (OSD), and other DoD organizations. JWARS will be capable of performing Courses of Action and Force Sufficiency analyses at IOC, and will be able to perform System Effectiveness and Trade-off analysis and Concept and Doctrine Development at FOC.

This presentation will provide insight into the assessment process of JWARS. The assessment process includes both Verification & Validation (V&V) and Test and Evaluation (T&E) which are outlined in the JWARS V&V Plan and JWARS Test and Evaluation Plan (TEP). The V&V Plan, as required by the JWARS ORD, follows the guidance outlined in the DoD VV&A Recommended Practices Guide (RPG), modified, where appropriate, for the JWARS V&V effort. The T&E Plan, as also required by the JWARS ORD, follows the guidance outlined in the DoD 5000.1 and 5000.2 acquisition documents for ACAT III level programs and Automated Information Systems (AISs), modified, where appropriate, for the JWARS T&E effort. The Joint Analytic Model Improvement Program (JAMIP) is the proponent of the JWARS model. The associated JAMIP Executive Committee (EXCOM) and Steering Committee (SC) are the associated approval authorities for the V&V process and T&E process. This presentation will discuss the importance of the assessment process, user interface, verification and validation activities, test and evaluation activities, documentation procedures and reporting criteria. The V&V as well as the T&E processes encompass the internal JWARS office efforts as well as the V&V agent and Operational Test Agencies interface with the user and test community.

Strategies and Techniques for Automation of Data Management and Reduction to Support Real - Time and Near Real-Time Data Analysis.

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The JT&E programs like many other test and evaluation programs collect large quantities of data to answer measures of performance (MOPs), measures of effectiveness (MOEs), and program issues. Often subject matter experts and the analysts are called upon to provide short notice or quick-look analyses and summaries of the data, MOEs, and MOPs. Limited time, personnel, and resources can make this a rather daunting task. Even supporting interim and final reports can present a challenge to the analysis group. With the advances in computer software, a well-designed data management and analysis program can make report generation and quick-look support quite manageable. The key to efficient use of computer resources is selecting the appropriate software for the task at hand. i.e. using Access for data management, relationships, and merging data while using the SPSS statistical program for advanced statistics and presentation efforts.

The Joint Close Air Support (JCAS) Joint Test Force (JTF) has a very complex model, which includes over 260 MOPs and MOEs, to describe the joint close air support process. To manage the data and automate the data analysis, a relational database was developed using Microsoft Access. Access was able to mathematically model the JCAS process by providing relational links between the tables (sub processes). These relational links also provided the capability to merge test conditions with appropriate test measures. The power of Access permitted real-time updates of test measure data and quick-look analysis of test measures and test conditions. Through visual basic programming and export of test measure data to Excel, near real-time readouts of all test measure values and some descriptive statistics were available with breakouts by individual battle or for the cumulative test program. Access was also used to provide preliminary marking of records each test measure for analysis. This relational database with marked records was imported into SPSS, a statistical analysis package, for more detailed descriptive analysis, ANOVA analysis, and sensitivity studies. Automation and macros were also used in the SPSS programs to reduce development and analysis time.

The Value of Test and Evaluation

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The value of Test and Evaluation to the Acquisition community has long been a topic of discussion. The acquisition community often views testing and evaluation as evidence of system ineffectiveness rather than as a means to discover the true capabilities of the system. The cost of testing is historically only a few percent of the total program cost. The value of test and evaluation is demonstrated with anecdotal examples of test and evaluation implementing changes in systems prior to production or in upgrades. The examples will be drawn from Army Live Fire Test and Evaluation programs and Joint Live Fire Test Programs. The examples demonstrate discovery of reduced capability improved as a result of testing and evaluation.

Joint Warfighters (JWF) Joint Test and Evaluation (JT&E)

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On 14 August 1997, the Office of the Secretary of Defense (OSD), Deputy Director, Developmental Test and Evaluation (DD, DT&E), Strategic and Tactical Systems (S&TS), in cooperation with the Joint Chiefs of Staff and Services, chartered the JWF JT&E. Over a four-year period, JWF conducted a series of test events that focused on joint operations against time-sensitive surface targets. Specifically, the JWF JT&E:

1. Established a baseline case by evaluating and documenting current time-sensitive target processes and procedures in realistic operational scenarios
2. Identified and verified potential deficiencies and opportunities for improvement
3. Identified, installed, and tested potential improvements in environments as closely aligned with baseline measurements as possible
4. Evaluated the effectiveness and suitability of the potential improvements

The JWF JT&E conducted tests in conjunction with Ulchi Focus Lens 99, Blue Flag 00-2, Ulchi Focus Lens 00, and Internal Look 01. This presentation will focus on the JWF test concept, test methodology, and test results.

Combining Live and Virtual Simulations to Operationally Test Electronic Countermeasures Against Modern Surface-to-Air Missile Systems

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This presentation describes preliminary results from a FY 2002 project funded by the Threat Systems Integration Working Group. We explain the design and analysis of a series of experiments conducted in the Air Force Electronic Warfare Evaluation Simulator facility. These experiments were designed to identify important and unimportant hardware-in-the-loop modeling considerations. The specific application is operationally testing electronic countermeasure systems that attack modern surface-to-air missile systems using seeker-aided ground guidance schemes. These missile systems use a hybrid guidance that combines target tracking radar and semi-active seeker inputs within the tracking loop. The tracking loop is closed on the ground and guidance commands are sent to the missile. Because both sources can be used in a guidance solution, the effect of a countermeasure is difficult to observe without actually shooting a missile. Some alternatives to live

shots include ground-mounted seeker tests or tests using a seeker flown on a test bed aircraft. But, aside from other difficulties, these solutions significantly limit the ability to fly operationally realistic test scenarios. An option that does not restrict open-air range scenarios, and the one considered here, is to fly against a target tracking radar in a live simulation, record the results, and then use those results in a virtual hardware-in-the-loop simulation that adds a missile seeker. The experimental strategy starts with an initial screening experiment to sift through a set of candidate factors and identify those that could have significant impacts on selected responses. Follow-on experiments resolve confounding, estimate the nature of important main effects, and identify important interactions. The goal is to produce a set of guidelines for operational testers to use when planning, conducting, and evaluating combined tests.

Global Command & Control System T&E

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The Joint Interoperability Test Command (JITC) is forging new ground as the Operational Test Agency (OTA) for the Global Command and Control System (GCCS). GCCS is an automated information system designed to support situational awareness and deliberate and crisis planning with the use of an integrated set of analytic tools and flexible data transfer capabilities. GCCS will be the single Command, Control, Communications, Computers and Intelligence system to support the Warfighter from the foxhole to the command post.

The size and complexity of GCCS, coupled with the unique acquisition strategy and the dynamic schedule, pose challenges for the test community. JITC has developed a comprehensive strategy for GCCS Functional Qualification Testing (FQT) and Operational Test and Evaluation (OT&E). This strategy is designed to meet the unique challenges posed by GCCS and provide timely information to the Warfighter, Department of Defense (DoD) Joint Staff, Director Operational Test and Evaluation (DOT&E), Defense Information Systems Agency (DISA) and the Milestone Decision Authority (MDA).

As the operational tester for GCCS, JITC ensures the Warfighter's perspective is captured as value-added to the development process. During each Field Test JITC assesses the operational effectiveness and operational suitability of the GCCS version release under test.

Through interoperability certification, we ensure the Warfighter can obtain information that is accurate, timely, and useful. Based on the Warfighter's requirements for information exchange and through our efforts in evaluating incremental software releases, we help assimilate new and affordable technology more quickly into our fight and win systems.

Mechanical Physics of Failure Initiatives

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This paper outlines the mechanical physics-of-failure (PoF) initiatives being performed by the US Army. The first mechanical PoF initiative is the ongoing analysis of an Army trailer, which uses an integrated process of dynamic modeling, finite element modeling, and durability analysis. The modeling approach starts by using terrain data gathered by the Aberdeen Test Center for use in the dynamic models. The dynamic model used in this project is multi-body model Dynamic Analysis Design Simulation (DADS). DADS is used for a rigid-body analysis and a flexible-body analysis, using finite element analysis. The flexible-body DADS model is used to determine the dynamic accelerations at all points on the trailer. NASTRAN is used as the finite element model in this project. Finally, the University of Iowa, Durability and Reliability Analysis Workspace (DRAW) software tool will be used to integrate results from dynamic modeling and finite element modeling (i.e., dynamic stress and strain) for durability analysis. This project outlines an approach to mechanical reliability analysis that can be used early-on in design.

The tools developed during the trailer project are also applicable to Test & Evaluation (T&E) related issues. The Improved Ribbon Bridge (IRB) and the Dry Support Bridge (DSB) acquisition programs sponsored by the US Army Tank-Automotive and Armaments Command, are utilizing PoF fatigue analysis tools to evaluate the structural fatigue induced by physically simulated loads applied during testing and compare them to real-world usage loads. In this application, PoF tools will enable substantial test cost savings by serving as the validation tool to accredit the physical simulation Modeling & Simulation (M&S) being employed on these programs. Other uses of PoF in support of T&E include Dynamic Modeling, Finite Element Analysis (FEA), and Life Prediction for early evaluations, corrective action verification, and what-if analyses.

Resampling Statistics and Designed Experiments

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For those of us that teach statistics, one result is clear: most people find the subject difficult and confusing, leading to either failing to apply the correct methods in real world problems or failing to apply statistics at all. Dr. Julian Simon, a founding father in the field of Resampling Statistics (1967), believes that the inherent difficulty in statistics lies in the difficulty of the concepts addressed – the ideas of random variation, sampling error, and the development of appropriate reference distributions to approximate the true behavior of quantities computed from an experimental sample.

Dr. Bradley Efron, of Stanford University, independently developed a general resampling method he called the "bootstrap", in the 1970s. The basic idea is that all the information we have about a sample is contained in that sample; we have no a priori knowledge that the sample came from a specific type of distribution. Since that's true, let's treat the sample as the proxy universe that all samples come from. Everything else in bootstrap follows from that simple idea. It's been claimed that bootstrap is the only revolutionary idea to come along in statistics since the 1930s. In fact, Fisher seemed to understand the philosophy of bootstrap very well. It's just that he didn't have the computing power to make it practical. For most of the lifetime of statistics as a discipline, much of our efforts have centered around finding ways of making calculations simple, often by assuming a particular distribution pertains. Now that we have all the calculating power we need, we should shun such assumptions when unwarranted. According to Simon, the bootstrap with its theoretical underpinnings, has now swept the field of statistics to an extraordinary extent. The New York Times had this to say:

> "`There's no question but that it's very, very important' said Frederick Mosteller, a statistician at Harvard University...Jerome H. Friedman, a Stanford statistician who has used the new method, called it `the most important new idea in statistics in the last 20 years, and probably the last 50'. He added, `Eventually, it will take over the field, I think.'" (Nov. 8, 1988, C1, C6)

We are in the process of determining whether Dr. Friedman is correct. Design of Experiments has revolutionized testing at the 53rd Wing, Eglin AFB, but we continue to struggle with generating enough practitioners of the method to address all the tests undertaken by the Wing. The chief difficulty lies not in the formulation of orthogonal designs (we can teach that in an afternoon), but in teaching the foundations, mechanics and extensions of the Analysis of Variance (ANOVA) to analyze the sample (now 2-3 weeks).

This paper represents a status report on a work in progress – determining how the attractive aspects of resampling statistics can be applied to the multivariate problems of experimental design. We will summarize the background of resampling statistics, and then classical and resampling approaches to estimating sample size, dealing with missing data in balanced ANOVA designs, treatment of non-standard MOPs (e.g., percentiles vs. means.), and the contrast between teaching classical ANOVA and multivariate resampling.

Joint Global Positioning System Combat Effectiveness (JGPSCE) Joint Test and Evaluation (JT&E)

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On 29 July 1999, the Office of the Secretary of Defense (OSD), Deputy Director, Developmental Test and Evaluation (DD, DT&E), Strategic and Tactical Systems (S&TS), in cooperation with the Joint Chiefs of Staff and Services, chartered the JGPSCE JT&E. Over a four-year period, the JGPSCE Joint Test Force (JTF) is conducting a series of test events that focus on joint operations where the Global Positioning System (GPS) is denied or degraded by hostile electronic warfare (EW) or friendly electromagnetic interference (EMI). Specifically, the JGPSCE JT&E is addressing the following issues:

Issue 1: What is the impact of GPS vulnerabilities on the effectiveness of joint operational missions that require precision engagement?
Issue 2: What changes in joint tactics, techniques, and procedures (TTPs) or system-level mitigation techniques improve or maintain joint operational mission effectiveness in the event of GPS EW and EMI?

Issue 3: What test methodologies can be employed to characterize GPS vulnerabilities in future acquisition and integration programs?

The JGPSCE JTF conducted its second field-test—*GYPSY BRAVO*—from 11 Jan 02 through 25 Jan 02 at Fallon NAS, NV. *GYPSY BRAVO* test participants included Air Force F-16C Operational Test Crews, Air Force F-15E Operational Test Crews, Navy and Marine F/A-18 Operational Crews, and Army AH-64D Test Crew. Crews conducted interdiction missions in the context of a medium-scale contingency scenario. This presentation will focus on the *GYPSY BRAVO* test concept, test methodology, and test results.

Dynamic Interface Modeling and Simulation System (DIMSS) : Just How Good Is It?

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With the new war on terrorism, the US military will increasingly host Army/Air Force helicopter assets onboard Navy ships. For experienced Navy helicopter pilots, the shipboard environment is not a new realm—but what if it is your first time to land your Blackhawk (with Bingo fuel) on a pitching and rolling FFG (guided missile frigate) deck with no airborne SAR support at twilight? Will you be able to follow the (Landing Signalman Enlisted) LSE command to land in spite 30-knot winds and a high sea state? In these situations, the Navy-certified launch/recovery wind envelopes become of primary importance—but their development is a time-consuming and even dangerous task. This "Dynamic Interface" issue is one the Joint Shipboard Helicopter Integration Process (JSHIP) was tasked by Office of the Secretary of Defense (OSD) to answer.

The modeling/simulation program within JSHIP is called the Dynamic Interface Modeling and Simulation System (DIMSS). Recent advances in simulation technology, including the ability to host applications on standard PCs, have allowed DIMSS to use the last two years to integrate a variety of computer models, including visual/aural/motion, and create a high-fidelity shipboard/helicopter simulation. The simulation, supported by NASA Ames' Vertical Motion Simulator (VMS), is designed to investigate the combination of a UH-60A and a Navy Amphibious Assault Ship (LHA). Using extremely limited at-sea test data, DIMSS took on the task of validating the simulation in applications supplementing flight test—another possibility is use in the training arena. JSHIP used an analysis of variance (ANOVA) approach to analyze the test results. An international accreditation board was convened to examine the results and evaluate the fidelity and utility of DIMSS. This presentation will focus on the ANOVA analysis and the potential to continue to expand simulation support of flight testing.

Measuring Performance of Small Units with Value Models

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This paper presents work in progress currently being performed for Ground Weapons Directorate at MARCORSYSCOM, Quantico, Virginia by SAIC. It outlines a methodology for establishing the baseline capabilities of a Marine Infantry rifle squad and subsequently measuring its worth. The methodology links existing T&O equipment to Mission and Individual Performance Standards and to a set of 42 squad functional capabilities (SFC). An objective hierarchy of six functional categories (mobility, lethality, C2, survivability, sustainability, and training) was created and all SFCs were decomposed across the six FCATs. Each SFC represents one or more common tactical behaviors and at the intersection of the SFC with the FCAT, a unique set of metrics (MOE/MOPs) was developed to represent the behavior. Each metric is linked to a single criterion, linear utility function having arguments directly related to equipment and/or benchmark requirements established in training or other literature. The team created 42 SFC value models containing unique metrics associated with each tactical behavior. Aggregation of all SFC valuations over the six FCATs provide a baseline squad worth index that is usable for comparing new technology and/or differing equipment being considered by the program manager. An application program, the Infantry Capabilities Assessment Model (ICAM) was developed to implement the methodology for the IICS project office.

Application of the Model-Test-Model Process to the Bradley A3 Force Effectiveness Evaluation

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The A3 recently received a Full Rate production decision, after undergoing significant DT and OT. ATEC's independent evaluation included an assessment of force effectiveness, which was based on results from the Initial Operational Test (IOT), along with pre- and post-IOT modeling. The modeling effort was conducted by TRAC-WSMR, in coordination with the ATEC. The modeling and simulation effort used the Combined Arms and Support Task Force Evaluation Model (CASTFOREM) to focus on three key improvements of the M2A3 Bradley Fighting Vehicle: the Improved Bradley Acquisition System (IBAS); the Commander's Independent Viewer (CIV); and the Fire Control and Missile Guidance System. These improvements are vital components to the increase in lethality and survivability of the M2A3 over the M2A2 version of the Bradley. The primary objectives of this Model-Test- Model effort were to assess the adequacy of the proposed test scenarios prior to the test, to address test requirements and better understand test parameters in a force-on-force environment, use test data and results to calibrate the model for credibility and realistic representation of the tested systems, and to extend the test results using foreign systems not available for the test event. This presentation discusses the Bradley A3 Model-Test-Model concept as applied to the Bradley A3, a brief summary of overall force effectiveness evaluation and results, including a discussion of pre-IOT CASTFOREM modeling effort, results of the IOT and the model calibration effort, and a summary of the post-IOT modeling effort. In addition, the lessons learned for both T&E and modeling will be presented.

Herding Cats—Leading an Operations Analyst Reinvention Effort in a Dynamic Electronic Warfare Group.

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As Ralph Waldo Emerson noted, "Fear always springs from ignorance." Change is generally a feared and fought aspect of operations in an office or unit, especially when the changes is instituted by superiors and forced downward to the lower levels. If the workers do not understand the need or purpose for the change, it will probably never be fully adopted at the lower levels. Without adopting the changes, an office or unit cannot incorporate new ideas, methodologies and processes which could increase efficiency and productivity.

This presentation documents and discusses some of the these issues in aspects of the 53rd Electronic Warfare Group (EWG) as it adopts and incorporates a different (not new) approach for conducting Test and Evaluation in a constantly changing environment. This methodology, called Experimental Design, was enthusiastically adopted by the leadership of the 53 EWG; however, its incorporation as a standard testing methodology was not openly accepted at the lower levels. As a result, many man-hours were expended educating members of the lower levels in this new methodology. This presentation will deal with many aspects of incorporating a large change in a dynamic unit, including the perils and pleasures of reinventing test processes from traditional methods, clarifying the vision, focusing the efforts, squelching rumors, ensuring accurate communication, organizational inertia and promoting acceptance at all levels.

Anti-personnel Landmine Alternatives (APLA) Non-self Destruct Alternative (NSD-A) Target Activation Study

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The Target Activation Study was conducted to describe the performance and effectiveness of APLA minefields employed with and without target activation, where target activation is defined as the event when an intruder (the target) autonomously activates the lethal effects without the intervention of a human controller. The analysis applied a triad of live,

virtual and constructive simulations to address key sensitivity issues which include: minefield density, intruder speeds through the minefield, controller timelines in chemical protective gear and the impact of interruptions in the communication link between controller and the deployed minefield (s). The study concluded that NSD-A munitions with Target Activation outperform NSD-A munitions without Target Activation under the following conditions: when the communications link is interrupted; when the operator was in MOPP gear; for significant increases in the intrusion speed for the OPFOR, and for operational timeline delays from mine trigger to detonation command greater than 10 seconds. Without the Target Activation feature, NSD-A munitions are not militarily.

Millennium Challenge '02 Data Instrumentation Techniques

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Army Transformation Experiment '02 (ATEx02) is the Army Experimentation Campaign Plan (AECP) event supporting the US Joint Forces Command (USJFCOM) experiment Millennium Challenge 2002 (MC02). MC02 is a major field experiment integrating Service and Special Operations Forces capabilities, consisting of both live and simulated forces. MC02 is designed to demonstrate the US forces capabilities to conduct Rapid Decisive Operations (RDO) in the 2007 timeframe.

This presentation describes data instrumentation and collection requirements and analytical approach required for one specific ATEX02 issue. The issue surrounds augmentation, reorganization, and additional capabilities required for an Army corps headquarters (HQS) to serve as a Joint Task Force (JTF) HQS. A corps HQS must have a mission-capable organization with an organization and supporting staff prepared to assume the role of a JTF in a combined operational environment. JTF's typically require augmentation. For a conventional Corps staff, this is normally an uncomfortable adjustment. Traditionally, a Corps staff has relied upon another U.S. headquarters (Army) to resource, synchronize and provide guidance, direction and approval. The presentation describes novel techniques for data instrumentation and addresses data collection issues in ATEx02 surrounding experimentation, observation, and analysis. It addresses MC02 jointly collected data and results analysis that will be required for this important Army issue. It describes how Army analysts will leverage data collection from GCCS (COP), GCCS (I3), and TBMCS at all the main and forward sites, e.g. JTF headquarters (main and forward) and functional Joint commands. This effort will require LAN probes such as SPECTRUM™, log files, "sniffer" data, and wide area network (WAN) probes. The presentation also describes innovative techniques for obtaining data and "screen captures" from the Information Work Space™ (IWS) collaboration environment at each of these Joint sites and afloat required during MC02.

Future Combat Systems (FCS) and the Joint Distributed Engineering Plant (JDEP)(A Potential Venue for FCS Joint Experimentation)

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The Army is accelerating the acquisition of FCS to meet the transformation goals of the Chief of Staff of the Army (CSA), and DoD. Concurrently, OSD and other joint agencies are implementing JDEP. JDEP will provide a distributed test-bed for Service developers, testers, and warfighters. The time is right for the Army to try to bring these two programs together to support joint warfighting concept exploration, and Army acquisition officials in achieving a FCS First Unit Equipped (FUE) in FY2008. JV2020 promulgates a network centric warfare environment that can potentially provide unprecedented levels of situational awareness to the lowest tactical echelons. FCS network centric concepts have to be demonstrated to support acquisition decisions. Due to the complexity of the problem, the Army should develop small "scoping" experiments to evaluate net-centric warfare. This presentation will explore three compelling reasons why the Army should incorporate a JDEP construct in the FCS Test and Evaluation Master Plan (TEMP). First, by employing JDEP the Army will show commitment to FCS interoperability, and a means to assess network centric warfare development in a joint context. Secondly, it will be a method to incrementally test Command, Control and Communications On The Move (C3OTM); thus, illuminating some of the sensor to shooter linkages, responsiveness, latency, and throughput issues that the developer will have to consider for FCS. Finally, JDEP could support a compressed acquisition timeline by integrating live, virtual, and constructive simulations for testing FCS C4ISR concepts. The presentation will conclude with a "way ahead" for future FCS C4ISR testing approaches.

Verification, Validation, and Accreditation of MUVES/S2 for U.S. Army System Evaluations of Ground Combat and Munitions System

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For DoD and service decision makers, technically astute and fiscally sound testing is critical to accurately quantify the survivability and lethality of U.S. ground combat and munitions systems in analysis models and wargames. At the weapon system level, deliberate Army experimentation has been used to fill critical data voids and to develop new model algorithms. These efforts have proven instrumental to incrementally extending the applicability of the tri-service AJEM/ MUVES-S2 analysis code for ballistic survivability/vulnerability/lethality analyses of U.S. Army and foreign weapon systems. These rigorous efforts are providing a critical foundation for analyzing new and emerging weapon system technologies. Algorithm and code advances are also supporting Analyses of Alternatives, U.S.C. Title 10 Live Fire Testing, and DoD 5000.2. In February 2001, the Army Test and Evaluation Command (ATEC) accredited MUVES/S2 for use in system effectiveness evaluations to support the Bradley M2A3 program and for use in shot line analyses, live fire pre-shot predictions, and generating full-view system-level metrics for combat systems and munitions. In December 2001, the Army Research Laboratory presented another compelling MUVES/S2 validation package to ATEC for the BAT program. These efforts will be leveraged to support other munitions in Army development such as GMLRS and P3I BAT. This paper succinctly describes the analytical approach, testing methods, analysis techniques, and modeling advances that are being applied to support the evaluation of ground combat and munitions systems for current and future frontiers.

C3 Test Driver Scenario Development

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The Command, Control, and Communications Test Driver program was initiated in response to a Deputy Undersecretary of the Army for Operations Research (DUSA-OR) tasking. The US Army Test and Evaluation Command (ATEC), the US Army Simulation, Training and Instrumentation Command (STRICOM), and the US Army Electronic Proving Ground (EPG) lead the C3 Test Driver Program. The Program involves key participants within the TRADOC Analysis Center (TRAC), the Central Technical Support Facility (CTSF), the US Army Operational Test Command (OTC), and the TRADOC Threat Support Directorate (TSD).

The objective is to support developmental, integration, and operational testing of Army Battle Command System (ABCS) components using standard models, standard mission/message threads, and standard scenarios.

The scenario development effort was tasked in Phase I of the C3 Test Driver Program (FY01) to produce an unclassified, brigade-level scenario to be used as the background for C3 Test Driver message generation and traffic. This scenario was located on the National Training Center and featured a Force XXI brigade against an opposing gorces division. Key events were identified within a scripted time-ordered event-list to initiate various mission/message threads. C3 Test Driver uses this message traffic to stimulate real systems under test, evaluate their performance, and facilitate developmental and integration testing.

Classified corps-division and brigade-level scenarios are being developed for use in Phases II and III of this program. These scenarios, and vignettes identified within them, will use a dynamic simulation and a robust set of doctrinal mission/message threads to additionally support operational testing and training.

Analysis of Alternatives WG-26

Chair: Bruce D. Wyman, Northrop Grumman Information Technology
Co-chairs: COL Patrick D. Vye, US Army, DUSA(OR)
Patricia Hickman, Headquarters, Air Combat Command
Tony R. Bellach, Air Force Materiel Command, Office of Aerospace Studies
Advisor: Lt Col David W. Samples, Office of the Asst Secretary of Defense, Program Analysis & Evaluation
GIF 254C

The following abstracts are listed in alphabetical order by principal author.

Predator Antiarmor System Analysis of Alternatives (AoA)

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The Marine Corps is approaching a fielding decision on the Predator, a system designed to satisfy the Marine Corps' Short-Range Assault Weapon (SRAW) requirements. Because of the significant cost growth of the Predator since its last Milestone, and its failure to meet reliability criteria in operational testing, the Marine Corps wants to explore less expensive alternatives to the Predator through a milestone III Analysis of Alternatives (AoA). To support the AoA, this study assessed the cost and operational effectiveness of a variety of SRAW alternatives. Because few, if any, of these alternatives meet all of the current Marine Corps requirements, this analysis quantified the operational risk associated with each of the alternatives, and investigated possible mitigations for this risk.

The analysis first identified a large number of potential alternatives for initial screening. Based on performance characteristics, and rough orders of magnitude of cost, this list was pared down to four basic alternatives. Counting the three distinct variants of one of these, Panzerfaust, there were a total of six alternatives chosen for further analysis. We also developed a wide spectrum of scenarios in which to compare the operational effectiveness of these alternatives. The next step evaluated the effectiveness of the overall MAGTF in each of these scenarios using a high-resolution combat model know as CASTFOREM. At the same time, we examined the life-cycle costs of each of these alternatives. Based on the effectiveness in the scenarios, and the costs, we developed additional alternatives/excursions to examine to try to mitigate the risk involved in selecting an alternative that did not meet all of the SRAW requirements. Using all of this input, we formulated the overall summary and conclusions.

Addressing the Cost and Value of C4I Information in AoAs

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The nature of major Air Force system acquisitions is substantially changing. The systems themselves are much more information dependent, and many of the Analyses of Alternatives (AoAs) for these acquisition systems must address a trade of money spent on information vs. money spent on warheads. This presentation will focus upon several significant steps the Air Force has taken to improve how it analyzes the value of information in AoAs, some still-needed improvements, and some problem areas as we continue to adapt the AoA process for C4I systems. The specific areas of discussion include how to cost C4I support to a weapon system and how to measure the "value" of C4I in a pre-warfare environment.

Using Analysis of Alternatives (AoAs) to Determine the Most Cost-Effective Systems for Acquisition (Providing Decision Makers Useful Information)

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This presentation discusses the process currently used by the United States Air Force to conduct an Analysis of Alternatives (AoA) in support of system acquisition and requirements development. AoAs can help justify the need for

starting, stopping, or continuing an acquisition program. They are done because decision-makers need reliable, objective assessments of the options for meeting real mission needs. AoAs identify potentially viable solutions and provide comparative cost-effectiveness assessments of each solution to a baseline, typically representing current systems and their funded improvements. AoAs are a big—but not the only—factor considered in selecting a final solution. The final decision, in addition to considering cost-effectiveness and military worth, must consider domestic policy, foreign policy, technological maturity of the solution, the environment, the budget, and a host of additional factors. AoAs also provide a foundation for developing operational requirements, concepts of operational employment, a test and evaluation plan for the preferred alternative(s), and much additional information of interest to a program office—if or when one is formed.

AoAs compare alternatives using proven methodologies in estimating their ability to satisfy the identified mission needs at a given cost. The results of these two analyses are combined to produce cost-effectiveness comparisons. The effectiveness analysis is built on a hierarchy of: (1) Accomplish campaign objective based on military strategy--e.g., halt advance; (2) Broad mission tasks (MTs) derived from the mission needs (e.g., kill tanks); (3) Measures of effectiveness (MOEs) indicating how well the mission tasks are performed (e.g., weapons expended for each tank killed); and (4) Measures of performance describing alternatives' fundamental capabilities (e.g., weapon delivery error). The life cycle cost analysis estimates how much each alternative will cost during its lifetime. AoAs need to also tie in the military utility of competing solutions. During the presentation sample measures of effectiveness and measures of performance will be discussed for various types of munitions, aircraft, space systems, and UAV systems.

Applying a Balanced Scorecard (BSC) Structure and Approach for the GCSS-AF Analysis of Alternatives

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This presentation provides brief overviews of both the traditional Analysis of Alternatives (AoA) process and the Balanced Scorecard (BSC) process. The authors then present a methodology for adapting and applying BSC techniques to conduct operational effectiveness/utility analyses for AoAs. The methodology is presented as a series of step-by-step procedures resulting in a completed BSC framework for accomplishing an AoA operational effectiveness analysis. The presentation concludes by identifying benefits to be gained by applying BSC techniques to the AoA process, as well as identifying cautions that the practitioner should keep in mind.

Crafting an Analysis of Alternatives for Milestone B: Thought Process and Requirements

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As a combat modeler, did you ever wonder why your tasker contains such difficult questions? Where do the writers come up with these ideas? As a system moves through the acquisition process, varying analysis needs to be done to gain insights into system capabilities and requirements to support acquisition decisions. For Milestone B, the alternatives being considered are the different components that comprise the winning system from the Analysis of Multiple Concepts. The example used for this discussion will be the Objective Individual Combat Weapon. For example, should the weapon have a 20mm single shot air-bursting munition with secondary kinetic energy weapon or 25mm semi-auto air-bursting munition without a kinetic energy weapon? Other factors, which need to be considered, such as training, cost of ammunition, human factors, etc. will be discussed.

Combat Rescue Analysis of Alternatives

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HQ ACC completed the USAF Combat Rescue (CR) Analysis of Alternatives (AoA) this past year. The presentation will discuss the operational effectiveness performed during the study. This AoA used many tools, including tool-kit models, new simulations, spreadsheet analysis, value models, and subject matter expert examination. The variety of tools provided insights of alternative effectiveness across the breadth of the recovery vehicle operations spectrum. The briefing will concentrate on the variety of tools and how they were used, although actual results will be presented where appropriate.

USAF Combat Rescue (CR) Analysis of Alternatives (AoA) Lessons Learned

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This presentation will address lessons learned during the USAF Combat Rescue (CR) Analysis of Alternatives (AoA). The presenter led the ACC team that recently completed the CR AoA. This study was lauded by several organizations as an example of how to do an AoA; especially impressive given the comparatively short time and funds. During the course of this study, the presenter gathered numerous lessons on what went well and what did not work as well. Although every AoA is different, these lessons should provide useful insights into the planning and execution of other AoAs.

Collaborative VV&A Process for AoAs

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The Office of Aerospace Studies (OAS) supports the modeling and simulation (M&S) accreditation process associated with Analysis of Alternatives (AoAs). The Air Force is currently conducting an AoA to replace the aging fleet of HH-60 Blackhawk helicopters for Air Combat Command's Search and Rescue mission. A major milestone leading to the final Air Force Requirements Oversight Council's decision in the spring of 2001 on the AoA is the accreditation of the M&S used to support the AoA. The purpose of the accreditation package is to measure the confidence in the M&S that is used to support the AoA. OAS led the accreditation development for the HH-60 replacement AoA by providing an M&S Verification, Validation and Accreditation (VV&A) process that exceeded the accreditation requirements established in Air Force Instruction AFI 16-1001. OAS developed a methodology to carefully scrutinize and document the M&S strengths and limitations before and after the analysis in an AoA. This was then processed into a formal VV&A report that supported the accreditation briefing to the accreditation authority. This paper will discuss the accreditation process and lessons learned to improve the quality and efficiency of an AoA M&S analysis. Individuals interested in model VV&A should attend to gain insight into this new technique of supporting the accreditation process.

The Development of the Future Combat Systems (FCS) Analysis of Alternatives Tasking Directive

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This presentation will provide an overview of the development of the memorandum that directs the conduct of Army requirements, acquisition and affordability analyses needed to support the Defense Acquisition Board (DAB) Milestone (MS) B decision review of an FCS system-of-systems in June 2003. It will address the methodology use to frame the analytical issues for a complex system-of-systems acquisition program. Moreover, the presentation will demonstrate how the directive attempts to synchronize and integrate analyses for a compressed acquisition timeline. The analysis and directive for the MSB decision in June 2003 will lead to an FCS MS C in 2006. Ultimately, this will support the Chief of Staff of the Army guidance to achieve an FCS First Unit Equipped (FUE) in 2008, Initial Operational Capability (IOC) in 2010, and eventual realization of full Objective Force capabilities.

Measuring Performance of Small Units with Value Models

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This paper presents work in progress currently being performed for Ground Weapons Directorate at MARCORSYSCOM, Quantico, Virginia by SAIC. It outlines a methodology for establishing the baseline capabilities of a Marine Infantry rifle squad and subsequently measuring its worth. The methodology links existing T&O equipment to Mission and Individual Performance Standards and to a set of 42 squad functional capabilities (SFC). An objective hierarchy of six functional categories (mobility, lethality, C2, survivability, sustainability, and training) was created and all SFCs were decomposed across the six FCATs. Each SFC represents one or more common tactical behaviors and at the intersection of the SFC with the FCAT, a unique set of metrics (MOE/MOPs) was developed to represent the behavior. Each metric is linked to a single criterion, linear utility function having arguments directly related to equipment and/or benchmark requirements established in training or other literature. The team created 42 SFC value models containing unique metrics associated with each tactical behavior. Aggregation of all SFC valuations over the six FCATs provide a baseline squad worth index that is usable for comparing new technology and/or differing equipment being considered by the program manager. An application program, the Infantry Capabilities Assessment Model (ICAM) was developed to implement the methodology for the IICS project office.

Anti-Personnel Landmine Alternatives Non-Self Destruct Alternative Target Activation Study

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The Target Activation Study was conducted to describe the performance and effectiveness of Anti-Personnel Landmine Alternatives (APLA) minefields employed with and without target activation, where target activation is defined as the event when an intruder (the target) autonomously activates the lethal effects without the intervention of a human controller. The analysis applied a triad of live, virtual, and constructive simulations to address key sensitivity issues, which include: minefield density, intruder speeds through the minefield, controller timelines in chemical protective gear, and the impact of interruptions in the communication link between controller and the deployed minefield(s). The study concluded that Non-Self Destruct Alternative (NSD-A) munitions with Target Activation outperform NSD-A munitions without Target Activation under the following conditions: when the communications link is interrupted; when the operator was in MOPP gear; for significant increases in the intrusion speed for the OPFOR, and for operational timeline delays from mine trigger to detonation command greater than 10 seconds. Without the Target Activation feature, NSD-A munitions are not militarily equivalent to current anti-personnel mines.

Analysis of Alternatives (AoA) for C4ISR Systems

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The Analysis of Alternatives (AoA) is the single most important analytical event in the material acquisition process. The purpose of the AoA is to assess the cost and operational effectiveness of a potential new system; and an AoA is required for both combat systems and for C4ISR systems. In the past, information systems, such as radios, situation awareness systems, and sensors, were often considered "enablers" for combat systems and a lesser standard of analysis was required. In recent years there has been a requirement to capture the operational benefit of such information systems in models and in AoAs. This paper discusses (1) U.S. Army C4ISR systems, (2) Key analysis issues related to C4ISR systems, (3) Key C4ISR tools and techniques, (4) Example C4ISR analysis results, and (5) Tool enhancements for the future.

Verification, Validation, and Accreditation of MUVES/S2 for U.S. Army System Evaluations of Ground Combat and Munitions System

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For DoD and Service decision makers, technically astute and fiscally sound testing is critical to accurately quantify the survivability and lethality of U.S. ground combat and munitions systems in analysis models and wargames. At the weapon system level, deliberate Army experimentation has been used to fill critical data voids and to develop new model algorithms. These efforts have proven instrumental to incrementally extending the applicability of the tri-Service AJEM/MUVES-S2 analysis code for ballistic survivability/vulnerability/lethality analyses of U.S. Army and foreign weapon system technologies. Algorithm and code advances are also supporting Analyses of Alternatives, U.S.C. Title 10 Live Fire testing, and DoD 5000.2. In February 2001, the Army Test and Evaluation Command (ATEC) accredited MUVES/S2 for use in system effectiveness evaluations to support the Bradley M2A3 program and for use in shot line analyses, live fire pre-shot predictions, and generating full-view system-level metrics for combat systems and munitions. In December 2001, the Army Research Laboratory presented another compelling MUVES/S2 validation package to ATEC for the BAT program. These efforts will be leveraged to support other munitions in Army development such as GMLRS and P3I BAT. This paper succinctly describes the analytical approach, testing methods, analysis techniques, and modeling advances that are being applied to support the evaluation of ground combat and munitions systems for current and future frontiers.

Cost Analysis WG-27

Chair: William M. Kroshl, Johns Hopkins University Applied Physics Laboratory
Co-chairs: Robyn Kane, Titan/Sencom
Maj Justin Moul, USAF, Air Force Cost Analysis Agency
LCDR Kelly Cormican, USN, U S Naval Postgraduate School
Advisor: Stephen Myers, Johns Hopkins University Applied Physics Laboratory
GIF 253C

The following abstracts are listed in alphabetical order by principal author.

Military to Civilian Billet Conversion in the USMC

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MARCORSYSCOM has developed a proposal to convert Marine billets into civilian billets to achieve greater effectiveness and efficiency for the command. In particular:

The proposal is to convert adequate number of professional acquisition workforce military (officer and enlisted) positions within the SYSCOM only (so that it excludes MCTSSA and AVTC) to government civilians to achieve an overall ratio of on-board military to civilian of 70:30.

The purpose of this analysis is to investigate the proposal to determine the underlying merits and costs.

This analysis has found that there is substantial merit to the proposal. It should achieve improved effectiveness at the Systems Command and provide a more stable workforce. At the same time, there should be adequate number of Marines remaining at the command to provide the needed expertise. Finally, it will return Marines to the operating forces in numbers that could make a difference for the field grade officer population.

There is, however, a cost to the Marine Corps for this proposal. We estimate about $5.2M per year O&MMC for civilian pay and allowances. There would be a small offset to this in savings in training costs. There may also be cost savings to systems development as a result of becoming more efficient, but these could not be quantified at this point..

Regression of Cost-Dependent CER's

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This paper proposes a revolutionary new way to estimate the cost of programmatic WBS elements, such as systems engineering, integration and test, and program management (SEITPM) in a way that more credibly accounts for the statistical uncertainty in these estimates. Historically, SEITPM has often been estimated as a function of the non-programmatic costs, such as spacecraft recurring hardware cost, while spacecraft subsystem costs have been estimated as a function of cost drivers such as weight. SEITPM cost estimating relationships (CER) are usually derived from actual spacecraft costs, but since we use estimated spacecraft costs when applying these CER's, we tend to misrepresent the total cost variance, leading to total cost distributions that are misleading. To remedy this problem, we should derive SEITPM CER's as a function of estimated spacecraft costs. This method adjusts the total cost variance, leading to more accurate total cost distributions.

Tutorial on General Error Regression Methods

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Historically, cost analysts have often used the framework of ordinary least squares (OLS) to develop typical single-variable and multi-variable cost estimating relationships. Unfortunately, the OLS framework has many limitations that

restrict its usefulness. For example, OLS requires the assumption that errors be additive (i.e., ., $y_i = b_0 + b_1x_i + \varepsilon_i$) and normally distributed with constant variance. This means the standard error of the estimate must be expressed as a uniform dollar amount across the range of estimation. Another limitation arises when using OLS to model curvilinear data with a log-linear model. For example, curved data is modeled by calculating the natural logarithm of y and x, applying OLS to the log data, then transforming the resulting model back into unit space (i.e $\ln(y_i) = b_0 + b_1\ln(x_i) + \varepsilon_i \Rightarrow y_i = ax_i^b \cdot \varepsilon_i$). This requires the assumption that curvilinear data have multiplicative errors. Moreover, this means the standard error of a log-linear model must be expressed as a percentage of the estimate. The general error regression framework, on the other hand, contains none of these restrictions. General error regression has been in the literature for many years, but has become much more practical in today's computing environment. General error regression separates the question of whether estimating errors should be additive or multiplicative from the question of whether the shape of the cost estimating relationship should be linear or non-linear. In addition, general error regression enables the cost analyst to be able to model practically any functional form (including $y = a + bx^c$, $y = a + b^x$, etc.). Finally, general error regression statistics can directly compare any two functional forms in terms of standard error of the estimate and goodness of fit.

Measuring the value of prewar C4I, and costing the contribution of C4I to the weapon system

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The nature of major Air Force system acquisitions is substantially changing. The systems themselves are much more information dependent, and many of the Analyses of Alternatives (AoA's) for these acquisition systems must address a trade of money spent on information vs. money spent on warhead. This presentation will focus upon several significant steps the Air Force has taken to improve how it analyses the value of information in AOA's, some still needed improvements, and some problem areas as we continue to adapt the AoA process for C4I systems. The specific areas of discussion include how to cost C4I support to a weapon system and how to measure the "value" of C4I in a pre-warfare environment.

MIDS Cost Estimating for Milestone II to LRIP II

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MIDS is a ACAT ID program that began development back in the early 90's. Methodologies with emphasis on Non-recurring and recurring PME will be traced from Milestone II through: a) Naval Center for Cost Analysis (NCCA) model, b) LRIP revised model, and c) current contractor pricing model. Lessons learned will be provided with emphasis of discussion on the various NCCA studies and learning/rate curves used.

Defense Budget: How was the Funding Spent?

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Approved abstract not available at printing.

Defense Budget: DOD's Portion of the FY01 Emergency Supplemental

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With the events of September 11, 2001, homeland defense and antiterrorism efforts have significantly impacted on Defense's budget. For example, the FY 01 Emergency Supplemental Act provided Defense with $17.5 billion in appropriations for broadly described activities such as increased situational awareness and increased worldwide posture. The purpose of this presentation is to illustrate what the U.S. General Accounting Office (GAO) found as the process that linked the $17.5 billion to requirements and obligations.

Forecasting Research and Development Program Budgets using the Weibul Distribution

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Norden (1970) demonstrates that the Rayleigh function can model manpower on research and development (R&D) programs. Several research efforts extend his work to modeling R&D program expenditures. The Rayleigh distribution, which is a degenerative of the Weibull distribution, suffers from some theoretical limitations that makes the Weibull function a better model for R&D program expenditures. Using 128 completed R&D programs, we develop regression models to predict the requisite Weibull scale and shape parameters. To determine the Weibull model's budget profile forecasting capacity, we compare the completed R&D program budget profiles to Weibull modeled budget profiles and report an average correlation of 0.607. To determine the significance of our results we compare the same 128 completed program budget profiles to Rayleigh modeled budget profiles. Using the Weibull in lieu of the Rayleigh model we improve initial budget profile projections on average 58%.

Comparison of Spacecraft Cost Model Correlation Coefficients

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The Unmanned Space Vehicle Cost Model Revision 7 (USCM 7) and Small Satellite Cost Model version 2000 (SSCM 2000) contain Cost Estimating Relationships (CER) for spacecraft bus components and subsystems, integration and test, and program level costs. Each of the CERs in the respective models contains inherent regression errors (expressed in percent error) that represent the uncertainty associated with the CER. These uncertainties are used in risk analysis to capture the total estimating uncertainty of a spacecraft bus estimate. A previously published paper, "Correlation Coefficients for the Unmanned Spacecraft Cost Model," provided the values of correlation derived from the residuals of the CERs as well as a method of calculating correlation between CER pairs. In this paper the correlation coefficients are derived for SSCM 2000 and compared to the correlation coefficients derived for USCM 7. This paper provides the correlation coefficients for the SSCM 2000, differences between corresponding correlation coefficients in the models, and the distribution of the correlation coefficients of both models. The paper asserts that correlation of uncertainties in each model, while following a similar and random distribution pattern, is not part of a causal relationship, is not similar between the two models, and is unique to a particular model.

Joint Cost and Performance Systems (J-CAPS)

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Methodologies in a Task Based Framework

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This presentation will discuss research in progress that focuses on the development of a methodology to assess the costs and benefits of the activities/tasks that comprise several scenarios produced by the employment of the Defense Modeling and Simulation Office Military Domain Representation Framework (MDRF). The MDRF scenarios exercise the range of Army operations, forces, and environments. The study that serves as the basis for this presentation seeks to identify 1] the measures used to assess mission effectiveness; 2] the activities that lead to mission effectiveness in the context of the identified scenarios; 3] the costs of the components of the activities; and 4] the issues encountered in the use of an activity-based costing methodology versus a more traditional costing methodology in the task-based framework relating performance to effectiveness.

Models to Improve Readiness & Cost Estimating

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An Army concept known as Simulation and Modeling for Acquisition, Requirements and Training (SMART) is improving the implementation of acquisition policy and collaboration across a variety of Army communities. SMART can help to achieve greater operational readiness for less life cycle cost and field systems quicker. This presentation covers five models that improve acquisition logistics policy implementation and collaboration to achieve SMART readiness and total ownership cost goals. Any U.S. Government agency or its contractors may use these models. Three of the five models are Army standard models. The other two, developed by the Army Communications-Electronics Command are standalone tools that can also link to the Army standard models. An introduction covering each of the five models is identified in Table 1 will be presented.

Table 1: Linked/Integrated Army Models

Acronym	Model Name	Type
ASOAR	Achieving a System Operational Availability Requirement	Readiness
SESAME	Selected Essential item Stockage for Availability Method	Readiness
COMPASS	Computerized Optimization Model for Predicting and Analyzing Support Structures	Readiness and Cost
ACEIT	Automated Cost Estimating Integrated Tools	Cost
LCET	Logistics Cost Estimating Tool	Cost

All of the models support early, informed decision-making across the domains of many different communities to help provide collaborative analyses. ASOAR, SESAME and COMPASS are models that optimize supportability to Ao requirements or goals. ASOAR can be used early enough in the acquisition cycle to evaluate and generate RAM and supportability requirements. ASOAR analyzes the mission reliability aspect of RAM, while COMPASS and SESAME analyze the logistics reliability aspect of item demand rates requiring equipment support. COMPASS, LCET and ACEIT are models that can be used together to provide a structured approach to optimize supportability and concurrently compute Life Cycle Costs (LCC). The integrated use of the COMPASS and LCET prior to fielding significantly improves the fidelity and credibility of logistics cost estimates relative to existing cost analysis models. LCET also contains macros that support earlier-on logistics cost estimates and its integrated use with ACEIT to cover the non-logistics cost estimates improves LCC estimating. Models that improve LCC estimating aid in the analysis and management of reducing total ownership costs.

Evaluation of Software Cost Risk: A look beyond the size parameter

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Within the Department of Defense, there is a tendency to estimate the risk associate with software development of in terms of size ranges. Bounding the estimate in terms of source lines of code (or function points) could be a viable method of capturing risk if all other aspects associated with software development were held constant. However, there are a number of additional factors that may impact the veracity of software cost estimation. Developmental standards (e.g., ISO 9001 and MILSTD 2167A), developmental methods (e.g., waterfall, spiral, and incremental), coding methods (e.g., third or fourth generation language, visual or code-generating techniques, and designing for reuse), and, personnel and environmental effects (e.g., skill level of software engineers, potential productivity of development team, multi-location development) are

all examples of knowledge bases and parameters that can affect the risk associated with the estimate. We hypothesize, in translating program risk into cost, there is a tendency to focus on the parameterization of size to the exclusion of these other, equally necessary assumptions. Moreover, we hypothesize the impact on standard software cost estimation equations due to variations in values assumed for non-volume variables may have a significant effect on overall assessments of program cost risk – potentially more impact than volume assumptions.

To translate software-intensive programs into dollar costs, assumptions about these other factors must be made. This presentation will put forward a framework to evaluate the effects of varying other input values and determining the impact on a software development cost estimate. From a macro sense, a researcher might parameterize a host of non-volume variables to determine the potential risk potential. It is our supposition that this project will be more useful to the estimating community by quantifying or calibrating the risk of minor to major changes in specific variable assumptions and their impact to the software cost estimate. We will focus on particular types or subsets of the potential factors, as the list of non-volume variables is quite large.

OSD (PA&E) Force Structure and Installation Support Cost Models

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This presentation will describe the capabilities and limitations of recently developed support cost models for military forces and installations/bases. Two models have been developed by OSD (PA&E) for the purpose of investigating the relative costs associated with various installation and military force structure alternatives. The Force Support Cost System allows Force Structure Analysts to determine the operating and support costs associated with Army, Navy, Marine Corps (and soon Air Force) forces and to estimate the cost impacts of changes in force structure and tables of equipment. The Installation Support Cost Model provides a capability for Force Analysts to evaluate the costs associated with various types of Army, Navy and Air Force installations and to estimate the impact of Base Realignment or Closure Actions on installation support costs. These applications will support rapid, credible, analysis and evaluation of the effects on resources and budgets that result from major force, support and infrastructure changes.

Decision Analysis WG-28

Chair: Gwen F. Delano, JWAC
Co-chairs: Daniel Dassow, The Boeing Company
David M. Hickman, HQ ACC/DRYS
MAJ Bob Larsen, Army, FDQ, FD Dir., Pentagon
Freeman Marvin, Decision Advantage
Mark A. Robershotte, Pacific Northwest National Laboratory
David V. Strimling, General Dynamics Land Systems
Christopher Zaffram, Naval Surface Warfare Center
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Bell Hall 24A

The following abstracts are listed in alphabetical order by principal author.

Information System Risk Assessment and Countermeasure Allocation Strategy

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This presentation details work in progress to conduct a Risk Assessment and Countermeasure Allocation Strategy for a military information system. This is a Joint Chiefs of Staff J6 directed effort that includes an inter-agency team with members from the National Security Agency (NSA), Defense Intelligence Agency, and Defense Information Systems Agency. This effort is intended to establish a methodology for conducting risk assessments at NSA that is repeatable, tractable, and defendable. A baseline version of the Global Command and Control System was used to vet the process. The methodologies used for the assessment evolved over time and incorporated information assurance testing, influence networks, fault trees, multi-attribute utility analysis, cost-benefit analysis, and a budget-constrained optimization. The presentation will also address difficulties and insights into the development of a mathematical model that satisfies three different organizations, accounts for positive countermeasure effects on the adversary, includes negative effects that countermeasures impart on the warfighter, and includes both Peace and Wartime scenarios.

Selecting Force Protection Initiatives Using Value Focused Thinking

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Decision makers responsible for enhancing force protection throughout the Department of Defense require additional insight when selecting force protection ideas, concepts, or technologies to pursue with constrained resources. They are faced with multiple criteria and have multiple objectives yet, have no defensible, objective, and repeatable, selection process to assist them in making their decisions.

The value-focused thinking (VFT) process is appropriate for providing the necessary decision insight to commanders and is applicable in the force protection arena. To prove the VFT process is appropriate and viable for force protection decision makers, this thesis focuses on constructing a value model, scoring alternatives, and analyzing the results for the Air Force Force Protection Battlelab.

The United States Air Force Force Protection Battlelab (FPB), at Lackland Air Force Base, Texas, has a mission to "rapidly identify and prove the military worth of innovative [force protection] ideas which improve the ability of the Air Force to execute its core competencies and Joint Warfighting" (AFI 10-1901, 1997:2). This mission necessitates the evaluation of many force protection related ideas in a time, personnel, and fiscally constrained environment. Prior to this thesis effort, the FPB had no objective, defensible, repeatable initiative selection process, now they do. This thesis has thus proven that using VFT as a decision assistance methodology for force protection decision makers allows them to make objective decisions regarding which innovative force protection ideas can contribute the most value to their mission. It provides justifiable defense for their decisions and enables future selection decisions with the same objectivity and defensibility.

Decision Analysis

Brigade Assault Bridging Analysis - BABA

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In realigning the Force Structure, rigorous and comparative analysis will be the hallmark to input in the decision making process. Systems being considered for acquisition will have to illustrate their worth to the Army before investments can be made. Recently, the Vice Chief Staff of the Army asked ODCSOPS to evaluate the Wolverine against the Armored Vehicle-Launched Bridge when considering Force Structure and Cost. ODCSOPS asked CAA to assist in the analysis. The purpose of the Brigade Assault Bridging Analysis (BABA) Study was to perform the comparative analysis of the capabilities of the AVLB against the Wolverine in a worst-case scenario. Given the extensive requirement for bridging assets in Korea, CAA used a Northeast Asia scenario. CAA considered the maintenance readiness, survivability and gap crossing capabilities in developing the model. The result of this study was a tool that allowed decision makers to assess their particular risk pattern and see the impact on Operational Planning in a Northeast Asia scenario. This, ultimately, provided input to the greater Force Structure and Capital Investment analysis that ODCSOPS provided to the Vice Chief of Staff.

Decisions and their Underlying Processes in the Joint Warfare System (JWARS)

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As might be expected in a next generation Theater Campaign simulation, JWARS makes a large number of decisions at multiple echelons. Furthermore, it must do so over a To compound this problem, JWARS has been tasked to operate with realistic C4ISR. This has meant operating only with an initial knowledge base and perceived information form interaction with the participants and the environment in the model. That has resulted in decision making under various degrees of uncertainty depending on the breadth and extent of the decisions. The decisions are also being made in a two (or more) sided environment where each opponent is attempting to thwart the plans of the other. Because of this complexity (and because of a requirement to run up to 1000 times faster than real time), JWARS has employed several different methods of decision making and treated them as components of a larger complex system of systems.

JWARS forces are represented at a level of detail and a breadth that has not been attempted before in long running, Theater-level models. This has meant a much larger number of units to command and control over a much longer time period with consideration of an integrated logistics system, stretching all the way back to CONUS. Consequently, there are more and more complex decisions to be addressed than in past theater models. This presentation describes the types of decisions being made in JWARS, the algorithmic methods underpinning them, and some of the successes and failures that have been achieved to date. Specifically, the presentation addresses:

- JTF Commander decisions related to Phase and ROE changes (rule sets)
- C4ISR fusion and intelligence generation (matrix algebra and rule sets)
- Land Course of Action Selection (game theory, simulation, and fuzzy sets)
- ATO (linear programs, greedy algorithms, and rule sets)
- Maritime and Missile Defense (multi-attribute optimization techniques and rule sets)
- Intra-theater Scheduler (shortest path (by time) in a constrained network)

This presentation also addresses the question of where might JWARS go from here and describes some efforts related to further improve decision making in JWARS. These include applying Bayesian networks to problems of aggregation, agent based complexity theory to assessment of situations and outcome prediction, and circumstance descriptors to the generation of plan fragments in an uncertain situation.

Effects-Based Modernization: Combat Air Forces' Planning and Programming Analytical Tool

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Air Combat Command has completed the development of an analytical methodology that supports effects-based planning and programming for the current Combat Air Forces Program Objective Memorandum, Mission Area Plans, and the Air Force Capabilities Investment Strategy. This briefing will illustrate that methodology and some useful techniques for presenting output.

The methodology evaluates the performance of today's Combat Air Forces against Defense Planning Guidance threats. First, a series of task hierarchies are used to evaluate the criticality of campaign- and system-level capability shortfalls. Then existing and postulated systems are evaluated for their contribution to CAF capability. Next, each system is evaluated to determine which capabilities require improvement based on current performance. Material solutions are then proposed that would reduce or eliminate a system deficiency currently contributing to a capability shortfall. Finally, materiel solutions are scored against a system capability hierarchy whose attributes are system and subsystem performance parameters and whose objective is to maximize system performance across a spectrum of conflict.

Effects-Based Modernization: CAF Center of Gravity Neutralization Capabilities Hierarchy

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Air Combat Command's Combat Air Forces' Planning and Programming Analytical Tool (CAFPPAT) uses a strategy-to-task framework to determine the magnitude of Combat Air Forces capability shortfalls in standard Defense Planning Guidance scenarios. This brief addresses the development of the offensive (neutralization of targets) capabilities piece of that framework.

The analysis of a series of OPLANs, the Air Force Task List, the Universal Joint Task List, the Modernized Integrated Database, and inputs from COMAFFOR campaign planners have produced a set of about 150 capabilities (target sets to neutralize). These capabilities are organized functionally into the effects the Air Force may desire versus potential adversaries. The highest level of the framework is based on John Warden's Five Strategic Rings. These tasks capture the offensive capabilities required for the Air Superiority, Global Attack, and (a subset of the) Information Warfare mission areas. This framework was used across three Combatant Commands to evaluate Combat Air Forces capability shortfalls in four AORs. The output is an integrated (across AORs) set of Combat Air Forces Needs.

Effects-Based Modernization: Combat Air Force's Aircraft/System Capabilities Hierarchy

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Air Combat Command's Combat Air Forces' Planning and Programming Analytical Tool (CAFPPAT) uses a strategy-to-task framework to determine the magnitude of Combat Air Forces capability shortfalls in standard Defense Planning Guidance scenarios. This paper addresses the development of the aircraft/system representation piece of that framework.

Each of the CAF's offensive systems has been modeled hierarchically in order to determine the performance shortfalls at the system- and subsystem-levels. System subject matter experts have built these assessment frameworks. They are organized into six high-level system functions:

- Effectiveness
- Survivability (Combat Attrition)
- Safety (Non-Combat Attrition)
- Logistical Footprint
- Sortie Rate
- Mission Capable/Availability Rate

The Aircraft Capabilities Hierarchy was used to evaluate the capability shortfalls existing in sixteen aircraft across four mission areas. The output is an integrated (across aircraft and mission areas) set of Combat Air Forces Needs.

Decision Analysis Support for the Global Combat Support System -- Army

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The Global Combat Service Support-Army (GCSS-A) will be the business automation enabler for the Army for interfacing and integrating information and enterprise systems across the combat support and combat service support mission areas, and support situational awareness for command and control. An Automated Information System, it consists of both hardware and software. Work to select an alternative was initially based on criteria and analytical techniques that would be challenging to defend. Application of Decision Analysis techniques provided a both an improved understanding of the decision situation as well as a solid quantitative basis for the decision.

USMC Engagement Strategy for the Horn of Africa

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The study examines the peacetime engagement activities in the focus countries to the U.S. Marine Corps component of CENTCOM (USMARCENT) in which Marine forces play either a principal or supporting role. A multiple objective decision analysis tool was developed to assess the effectiveness of these engagement activities. Alternatives are recommended that better advance USMARCENT objectives.

Beyond Quarterback Ratings: Using the "Whole Team" Approach to Hire a Championship Team for your Organization

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One of the most critical tasks any organization performs on a regular basis is the hiring of new personnel. Certainly this is true in the selection and "hiring" of faculty members at the United States Military Academy where faculty members are expected to not only teach and do research but more importantly to coach, mentor, inspire and serve as role models for their students/cadets who will serve as future Army officers. Previous research involved identifying the qualities most important when hiring a faculty member and the development of a decision support tool (DST) to assess and rank potential faculty members to assist in this hiring decision. The resulting DST allowed the decision-maker to quickly identify the top "overall" candidates. This begs the question, however, if we need to hire five new employees "Should we simply hire the 5 best candidates?" Perhaps our organization has particular needs that might be better filled with some combination of candidates other than the top five. Consider the case of drafting players for a baseball team. A strategy of selecting the 9 best athletes might leave you in dire straits if there isn't a pitcher among the top 9. In this paper we will build on the previous work, continuing our use of Multi-Objective Decision Analysis and incorporating Optimization and Portfolio Theory to develop a

decision support tool that will allow the selection of an optimal slate of candidates. We will begin by addressing the process for determining what "team" qualities are most important when hiring a slate of employees. We will then look at the identification of metrics that can be used in a decision support tool to assess and rank how well slates of potential employees meet these qualities. A case study, involving the generation and application of such a decision support tool to assist in the selection process of future faculty members in the Department of Systems Engineering at the United States Military Academy will serve as the backdrop for this discussion.

Objective Force Risk Analysis

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In the early 1990's the Army set the goal of applying risk management principles to all of its projects and processes. TRAC has begun a risk management analysis of the Army's transition to the future Objective Force. This analysis supports the development of Objective Force concepts by identifying the hazards most dangerous to future operations and most relevant to the transition process.

The presentation will cover, in addition to the results, the challenges of identifying the hazards, collecting the data (via a survey), and analyzing the data.

Survey Results on Modeling Objectives on Cost in a Decision Maker's Value Structure

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Following a previous paper entitled *Modeling Objectives on Cost in a Decision Maker's Value Structure*, the authors present the results of survey research conducted to determine whether or not the objective of minimizing cost should be included as part of the fundamental objectives hierarchy when modeling a decision maker's value structure. Conclusions are drawn for both practitioners and academicians. For practitioners, the discussion addresses which technique those who know and use decision analysis prefer and why. Suggestions for using the two competing techniques both separately and together are offered. For academicians, as a by-product of the surveys, survey results illuminate how much and what kind of decision analysis training and education is received by systems engineers, operations researchers, engineering managers, decision analysts and others. Hypothesis testing using the Chi-Square Test with Fixed Marginal Totals is used to validate certain points.

Determining the Homeland Security Force Structure Requirement

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Beginning in the spring of 2000, the Army undertook efforts to change the paradigm of treating Homeland Security as a lesser-included force structure requirement. The results of this shift led to the development of the Army Strategic Planning Guidance (coordinating draft, September 10, 2001). This planning guidance serves as the framework for determining the Army's force requirement to support Homeland Security. There are seven basic mission types that are covered in the planning guidance. The study employs three techniques to determine the requisite force structure for each mission type. This first technique involved collecting known information of current force structure that had a Homeland Security role. The second used a forecasting tool, Stochastic Analysis of Resources for Deployments and Excursions (SARDE) that used historical events to predict the average monthly force requirement for certain mission types. The final technique involved basic set theory to estimate the requirement based on several possible scenarios. The results of this study were used in the Total Army Analysis '09 process that determines the desired total active and reserve component requirements through year 2009. These results also give a defensible force structure that Army planners can use to convey its requirements to the Join Staff and sister services. Lastly, the study demonstrates how the Army is currently supporting the National Command Authority's efforts to ensure the safety and security of the nation.

Investment Analysis in Ballistic Missile Defense

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Developing an Investment Decision Analysis approach to Ballistic Missile Defense involves the evaluation and comparative analysis of elements that operate together under varying environments. Elements from the three segments of missile defense, boost, mid-course, and terminal, all need to be incorporated into the desired layered defense approach and comprise alternatives that differ on a number of evaluation criteria. To perform analyses across this layered defense requires the development of a set of benefit criteria that, when weighted and measured, does not create a bias in any direction. Both qualitative and quantitative date may be applied to comprise utility functions. Cost factors are also of significance with the examination of sunk costs, extensive research and development dollars and incorporation of unknown procurement, and operations and support costs. An approach of developing a common set of benefits and measuring utility, then applying decision support tools based on multi-attribute utility theory, has been utilized to develop a baseline. This baseline is being used to further examine utility over time and sensitivity of benefit weighting criteria for various BMD systems in this ongoing investment analysis.

Allocating the Army budget, insights into understanding and realizing a decision maker's values in a complex decision environment

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The Army uses a complex process involving dozens of people to develop the Army Program in the PPBS. Senior leaders are not satisfied with their ability to convey their programming guidance to the people who manage the process even though the senior leaders ultimately approve the results. We apply decision analysis to expose the underlying nature of the decisions that must be made and propose techniques by which the senior leaders can be sure to provide their programming guidance to the Program Element Groups that generate the programming options. One of the techniques that we will examine in detail is a tool that allows senior leaders to adjust constraints and proportions from multiple programming perspectives.

Risk-Based Decision Analysis Applied to Combat Terrorism

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Terrorism presents an asymmetric threat to military forces and assets that requires an understanding of potential hazards and the effects on the functions of military systems. To stop terrorist threats, effective countermeasures are necessary to deter, detect, defend, and mitigate against potential threat scenarios. Decisions for the implementation of countermeasures in the most effective and cost effective manner is a problem that can be solved with the assistance of decision theory tools. To help prioritize the need for potential countermeasures, risk-based decision-making may be applied.

Risk-based decision making requires the use of risk -based technologies that consist of risk assessment, risk management, and risk communication. Risk assessment identifies three main questions (1) What can go wrong? (2) What is the likelihood? and (3) What is the consequence? To help answer these questions, risk models developed from proven technologies such as event tree and fault tree analysis may be developed. Risk management provides tools for applying the risk assessment results for decision making. Risk communication establishes communications tools between all stakeholders in the decision process concerning risk.

The proposed risk-based decision process is being applied to analyze the problem of terrorist activity for SSBN security. These tools are intended to improve the decision process by prioritizing terrorist risk on targets functional capabilities and identifying the most efficient and effective countermeasure techniques.

Personal Finance Education and Portfolio Optimization for Investors in the U.S. Government's Thrift Savings Plan

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The Thrift Savings Plan (TSP) is a retirement savings and investment program designed for US government employees. It is similar to 401k plans offered by many civilian companies and allows participants to invest pre-tax dollars to reduce current taxable income and to defer the taxes of investments and earnings until withdrawal. The TSP recently opened participation to members of the uniformed services. Participants can invest in a choice of five funds, each with a historical risk/return profile. To date, sources available to educate investors in the TSP (www.tsp.gov, *Army Times* articles, etc.) have focused on descriptions of the funds and administrative aspects of participation. This paper addresses some of the deeper questions facing investors such as whether to participate in the TSP, factors in deciding how much to invest, and how one might optimally allocate money into the five funds based on an individual's risk tolerance. Questionnaires and other assessment and educational tools are identified that can aid in investor decision-making. For example, appropriate constraints can be established based on investor desires and assets currently owned and mean-variance quadratic optimization can be used to help the TSP participant choose an allocation strategy.

An Analysis of Engagement Coordination Methodologies of Aegis Platforms

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As both communications bandwidth increases and computing capability continues to become more sophisticated, the ability to share information and resource states across platforms in real time becomes more realizable. Thus, the potential for a complete realization of the vision of Network Centric Warfare comes closer to reality. With these advances and the constantly evolving, more dangerous threats, the need for multi-platform Distributed Weapon Control (DWC) becomes inevitable. DWC consists of three components, namely, Threat Assessment, Sensor Coordination and Engagement Coordination. Engagement Coordination is the utilization of forces, networked information and resources in a more effective way to defeat the enemy and is the topic of interest in this brief.

The High Performance Distributed Computing (HiPer-D) laboratory is a real-time laboratory located in Dahlgren Virginia where multiple Aegis tactical system platforms are prototyped in order to demonstrate proofs of concepts with respect to advanced computing architecture and algorithm development. There it was shown that a multi-objective algorithm could make a decision in a tactical environment in real-time by sharing fire control information across Aegis platforms. The next phase was to show value added to the battlegroup. This brief describes the current Engagement Coordination schemes in the Navy Fleet today. It then demonstrates through modeling how using shared high fidelity fire control information, platform state information across platforms and a multi-objective decision algorithm can improve battlegroup effectiveness. The focus of this brief is to show the value added using a multi-objective decision algorithm to select the shooter over the current Engagement Coordination schemes used in the Navy fleet today. Additional discussion includes how this methodology can be extended to other, non-Aegis platforms due to the generic criteria and required interfaces.

Modeling, Simulation and Wargaming WG-29

Chair: Jeffrey A. Dubois, Veridian Engineering
Co-chairs: William A. Sawyers, Marine Corp Studies and Analysis
James McMullin, Booz-Allen & Hamilton
David Wells, Air Force Agency for Modeling and Simulation
Karen Dillard, Office of Aerospace Studies
Advisor: Kenneth Dzierzanowski, The MITRE Corporation
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The following abstracts are listed in alphabetical order by principal author.

Joint Virtual Battlespace (JVB) – A Concept Evaluation Environment

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"The Army must change." So says LtGen John Riggs, Director of Objective Force Task Force. But how should it change? To understand how best to transform the Army to fulfill the defense needs of the nation in the 21st Century, there is a requirement for detailed, yet broad analysis of proposed concepts. Broad analysis must be done to insure the applicability of concepts and developmental systems in the context of likely and plausible future military scenarios. Yet the analysis must also dive deep into the details of information flow, communications, situational awareness, weapons and survivability, and at the same time support development of a wide family of new systems (Future Combat System) and others. Stovepipe analysis of a single weapon system, using a set of standard standalone simulations, will not meet this requirement. Instead, the Army is building an evaluation environment called Joint Virtual Battlespace (JVB) using the SMART (Simulation & Modeling for Acquisition, Requirements and Training) process. JVB is using distributed simulation to incorporate the best existing models and simulations as needed for evaluation of specific warfighting and weapon-system concepts. The emphasis in JVB is on integrating existing tools, not building new components unless absolutely necessary to bridge gaps between legacy models. The environment is tailorable to analysis needs by incorporating various tools when they are needed to answer specific questions. And is this not how analysis should work? First formulate the question, and only then select or build a tool to help answer it.

An initial study in support of Program Manager Aerial Common Sensor (ACS) is in the final stages. This ACS study provided a proof-of-concept for the JVB approach, and serves as the foundation for the JVB Federation Object Model and suite of models and simulations. The current focus of JVB is to support Objective Force analysis for TRADOC Analysis Center. For this effort, JVB is gathering a variety of models and simulations from STRICOM, Department of Energy's Sandia National Laboratory, the Army Research and Development Engineering Center, and other agencies and contractors. In the coming years, JVB will provide a robust, tailorable, and focused tool set to answer the question "How should the Army change?"

Pythagoras: The Newest Member of the Project Albert Family

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Pythagoras is a new Agent-based distillation, being developed to supplement/complement the Project Albert family of distillations, which include Mana, Socrates and Isaac. Pythagoras brings new capabilities to this family, such as Soft Decision Rules, Dynamic Sidedness, Behavior-Change Triggers and Non-Lethal Weapons. Soft Decision Rules create instances of Agents from the same Agent class that have behaviors that are unique from one another. Dynamic Sidedness allows Agents to change sides as a function of actions and events that they encounter. Behavior-Change Triggers allow Agents to change their behavior as a function of actions or events. Non-Lethal Weapons, not only cause suppression, but may also change the sidedness or affiliation of an Agent. Pythagoras Scenarios include a Cave Search scenario in which Marines look for an elusive Agent. A Peace Keeping Scenario has also been built in which Marines use short-range non-lethal weapons (like leaflets or food) to sway the affiliation of villagers, while an enemy is broadcasting propaganda with an indirect fire non-lethal weapon (a bull horn) to sway them against the Marines. Pythagoras is written in JAVA, and is hosted at the Maui High Performance Computing Center, where it is available for data farming - executing large numbers of repetitions of parametric runs to identify areas of unexpected behaviors and non-linear results in a co-evolving landscape.

Modeling, Simulation and Wargaming WG-29

Pursuit of New Battlefield Metrics through Simulation and Statistical Modeling

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The effectiveness of a commander's execution of a course of action (COA) is certainly dependent on the adaptive control exercised over his or her forces, which in turn depends on the information available about those forces, the enemy forces, and general notions of the battle flow. We discuss an ongoing investigation of battlefield metrics intended to enhance the information supporting the commander's decisions, especially as to specific events, conditions, or interactions that may probabilistically foretell the battle outcome. A small Southwest Asia scenario is simulated repeatedly in One Semi-Automated Forces (OneSAF). Standard outputs from OneSAF in addition to outputs from a new Killer/Victim Scoreboard utility developed at the Army Research Laboratory are used to support data mining of the battles. We envision that such an approach, given a believable and rapid simulation capability, could provide the commander insight to new and intricate battlefield parameters, thereby signaling at various stages of the battle to continue with the COA, adapt to an alternative plan, or break off the mission. We will share an example of insights to this specific scenario.

Co-Revolutionary Gaming

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This presentation describes a method of creating a robust competitive context, "Co-Revolutionary War Gaming." Using Co-Revolutionary War Gaming, players can quickly and inexpensively explore an extremely vast landscape of possibilities from many perspectives. This method re-introduces the classic premises behind scenario-based planning that the gaming community has abandoned in favor of automated analyses and closely scripted games. In addition to the classic elements of gaming, Co-Revolutionary War Gaming also employs a "landscape search" strategy similar to that examined in recent research into evolutionary biology. Recent results from a long-term investment strategy Co-Revolutionary War Game will be presented.

Modeling Maneuver Warfare Using SEAS

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The goal of military education is to help soldiers understand the nature of war and to teach them how to think logically and creatively about war and during war. Every great military leader understood that success in battle is attributed to well-trained forces. We intend to show that wargaming can play a major role in the course of instructing maneuver warfare techniques. Modeling and Simulation has a pivotal role to play in providing trainers with sound analytical support on training activities designed to teach maneuver warfare. Our study employed Systems Effectiveness Analysis Simulation (SEAS), an AF Toolkit campaign level model. In the past SEAS has been used by senior AF decision makers to determine future space systems policy. Future uses could be to provide analytical support to scenario construction and evaluation of the learning process, for individual or collective training. Our research applies the maneuver warfare principles from the Maneuver Warfare Handbook at the company level and below. It can be used to teach students to make educated decisions through a coherent, logical thought process. Advanced techniques such as unit skills, conducting a specific type of attack, and employing combined arms can be taught and demonstrated. The SEAS model was developed in such a way that it allows for "tactical programming", which permits the application of maneuver warfare techniques. Most computerized games try to

decide "who won" by rewarding "kills". SEAS, however, is designed to give the decision maker or instructor or student insight into the effects of variables. There is no right answer in maneuver warfare, only timely and logical ones.

Objective Force Concept Exploration, A Notional Combat Battalion Engagement

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This study supports Objective Force Combat Battalion concept development and the Army Transformation. It focused on developing, examining, and refining Combat Battalion concepts, and supporting the Future Combat System (FCS) Mission Needs Analysis.

The study scenario facilitates analysis of the Objective Force in combat operations. The scenario provides a context in which an Objective Force Combat Battalion conducts offensive operations in 2015 against a technologically advanced Red force. The engagement was explicitly modeled using the Interactive Distributed Engineering Evaluation and Analysis Simulation (IDEEAS) model. IDEEAS is an entity-based simulation, capable of force-on-force representations, that permits examination of concepts and parametric analysis at the engineering level of detail. Use of the notional battalion force structure allowed O&O concept exploration prior to force design decisions.

This study contributed substantially to the development of the Objective Force, especially with regard to the Unit of Action force design. In addition to the development of concepts, tactics, and insights for future operations the study provided a powerful visualization of this future force. The scenario and base case developed during this study were used extensively by the TRADOC Unit of Action Task Force in their subsequent refinement of the force design. These tools were also used by the Army Medical Department in its transformation wargame effort.

This presentation will provide an overview of the study scenario's purpose, methodology and results.

Combining Live and Virtual Simulations to Operationally Test Electronic Countermeasures Against Modern Surface-to-Air Missile Systems

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This presentation describes preliminary results from a FY 2002 project funded by the Threat Systems Integration Working Group. We explain the design and analysis of a series of experiments conducted in the Air Force Electronic Warfare Evaluation Simulator facility. These experiments were designed to identify important and unimportant hardware-in-the-loop modeling considerations. The specific application is operationally testing electronic countermeasure systems that attack modern surface-to-air missile systems using seeker-aided ground guidance schemes. These missile systems use a hybrid guidance that combines target tracking radar and semi-active seeker inputs within the tracking loop. The tracking loop is closed on the ground and guidance commands are sent to the missile. Because both sources can be used in a guidance solution, the effect of a countermeasure is difficult to observe without actually shooting a missile. Some alternatives to live shots include ground-mounted seeker tests or tests using a seeker flown on a test bed aircraft. But, aside from other difficulties, these solutions significantly limit the ability to fly operationally realistic test scenarios. An option that does not restrict open-air range scenarios, and the one considered here, is to fly against a target tracking radar in a live simulation, record the results, and then use those results in a virtual hardware-in-the-loop simulation that adds a missile seeker. The experimental strategy starts with an initial screening experiment to sift through a set of candidate factors and identify those

that could have significant impacts on selected responses. Follow-on experiments resolve confounding, estimate the nature of important main effects, and identify important interactions. The goal is to produce a set of guidelines for operational testers to use when planning, conducting, and evaluating combined tests.

Analyzing Anti-Terrorist Force-Protection Tactical Effectiveness using X3D Graphics and Agent Based Simulation

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U.S Naval Forces are increasingly the target of terrorist attack. There is a strong need to provide emerging technologies to forces afloat for analysis and visualization of tactical posture when defending warships in port. The SAVAGE research group at the Naval Postgraduate School (NPS) is building a large public-domain library of models and prototyping tools. We construct tactically interesting virtual environments using Extensible 3D (X3D) graphics, providing interactive displays either in standalone mode or via the Web. A sophisticated series of interactive Web-based 3D scenarios utilize georeferenced terrain, humanoid avatars, physically based models and networked agent-based simulation. For example, a sophisticated scenario for U.S. Marine amphibious assault shows key spatial relationships that can easily be overlooked if solely analyzing in a 2D context.

This presentation shows technical results representing conflicts between friendly and hostile assets, simulating complex ship-level Anti-terrorism and Force Protection (ATFP) measures. Specifically, we've built an agent-capable 3D reconstruction of the small-boat terrorist attack carried out by Al Qaeda on the USS COLE in October 2000 at Aden Harbor Yemen. These integrated models enable simulation, experimentation, visualization and statistical assessment for discovering potential shortcomings in force protection. A software-agent architecture capturing varied friendly and hostile representations is used to explore basic interactions, unforeseen threat combinations and even sensitivity analysis regarding skills, training and personality traits of defending personnel.

New applications of statistical analysis are possible using this methodology. Typically, outputs of interest include sequential-statistic means and standard deviations for various tactical measures of effectiveness (MOEs). For self-defense preparations, however, outlier scenarios that reveal unexpected tactical vulnerability provide new and critically important analytic outputs. The ability to plan, replay, analyze and replan realistic scenarios makes this approach valuable for both training and self-defense. In closing, we examine next steps for scaling models, simulations and statistics to battle group and theatre-level scenarios of tactical interest.

Wargaming to Support Objective Force Concept Development

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The Objective Force is the realization of the Army vision that was presented by the Chief of Staff of the Army (CSA) in October 1999. The transformation from vision to fielded Objective Force is a process that will occur over several decades. An early and critically important piece of this process is the development of Operational and Organizational (O&O) Concepts. These Objective Force O&O concepts are grounded in the futures work that was done as part of the Army After Next (AAN) project. Futures wargaming has evolved to become an important part in the development of these concepts. In particular, the annual Army Transformation Wargame (ATWG) has emerged as the Army's most visible event for future concept development.

The TRADOC Analysis Center (TRAC) serves as the lead analytic agency for the ATWG sponsored by the TRADOC Deputy Chief of Staff for Doctrine (DCSDOC). This series of wargames is designed to describe, refine and evaluate

Objective Force concepts and capabilities over a multi-year period. These wargames provide the Army an opportunity to explore future Army operations at the strategic and operational levels of war in a political/military wargame environment.

This presentation will address the analytic support provided to ATWG 01, *Vigilant Warriors*. In particular, it will provide an overview of the wargame to include analysis and reporting of the insights for the issues addressed.

An Integrated Gaming System for the Army Transformation Wargame

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The Integrated Gaming System (IGS) is an integrated, model-supported gaming system consisting of a set of tools linked to a common database and capable of supporting a wide range of gaming requirements. The U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC) provides contract oversight management for the development and use of the IGS in support of the TRADOC Deputy Chief of Staff for Doctrine (DCSDOC). The Wargaming and Futures Directorates within DCSDOC are the program and systems' sponsors.

The IGS is a Booz-Allen & Hamilton (BAH)-developed wargame automation system that fulfills the functional requirements of the Wargame Architecture (WGA) concept, which developed out of requirements identified by DCSDOC beginning in 1996. DCSDOC identified these requirements while preparing for a series of wargaming events that supported the Army After Next (AAN) future studies effort. The purpose of the IGS is to perform the functions of the WGA in support of TRADOC's Army Transformation wargame, study, and research efforts. This presentation provides an overview of the IGS system, its components, and its use during last year's Army Transformation Wargame - *Vigilant Warriors 01*.

An Application of Distillation Modeling to Studying the Enemy Within

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Ongoing research into how to develop better maneuver warriors through application of distillation modeling and data farming to questions regarding conflict is sponsored by the USMC's Project Albert. MITRE is supporting Project Albert's effort to develop tools to explore questions using a synthesis of both new and existing models. The approach is to use a series of new models/analytic tools, multi-disciplinary teams, and the scientific method to explore questions, exploit advances in computing power and visualization tools, and utilize the meta-technique of "Data Farming" to go beyond single point estimate and look at questions from the perspective of many data points. This presentation describes a set of recent applications addressing questions relating to "the threat within" including martyr-minded enemies, sabotage and corruption, incompetence, and false intelligence. A demonstration of the distillation tools employed in this research as well as data associated with this study will be discussed.

Integrated Communications Replication in CASTFOREM

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Objective Force and FCS are expected to rely heavily on integrated, seamless communications and situational awareness. Potential operating environments, including urban and other complex terrain, and geographical separation of entities within an operations area, both of which may affect communications, are factors to consider during the design of equipment, organizations, and doctrine.

High-resolution combat models do not typically play explicit communications at the entity level. Engineering-level models that could model communications do not typically replicate the interactions during combat operations, including

attrition, battle damage, and logistics. CASTFOREM currently has a fairly robust communications architecture portrayal, but it falls short in its ability to model the system of systems communications constructs of the proposed Objective Force.

This presentation discusses ongoing studies in further advancing the simulation capabilities of CASTFOREM, developing new descriptive algorithms for embedding communications within a high-resolution combat model, and detailing the shortcomings that even a perfect replication might possess. The presentation will also highlight some vignettes used to test the application as well as emerging results.

An Agent-Based Modeling Approach to Measuring the Value of a Proposed Information System

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For several years the U.S. Army and Department of Defense have struggled with how to measure the value of battlefield information. Digital information systems have demonstrated the potential to significantly increase the combat effectiveness of our forces, but in order to make procurement, force structure, and basis of issue decisions, we would like to gauge the extent to which these systems increase combat effectiveness. This paper describes a methodology we chose to investigate whether an agent-based-model (ABM) could be used to suggest appropriate behaviors for a combat force equipped with a proposed information system such as Future Battle Command Brigade and Below – FBCB2. The decision agents within the model will use the information about enemy forces, friendly forces, and terrain provided by the proposed information system to adjust the friendly course of action to the updated situation. Our methodology is a three-step process. We first execute simulation runs using an existing dynamic study scenario and evaluate the results of these runs. In the second step, we transfer the terrain, units, and course of action from the existing dynamic scenario to an ABM with intelligent agents that will refine the course of action genetic algorithm by generating new unit positions and routes based upon the current situation. In the final step, we substitute the ABM developed course of action and behaviors back into the dynamic study scenario and execute another set of simulation runs. The performance of the friendly force using the proposed information system and ABM generated behaviors may be compared to the performance of the friendly force which failed to take advantage of current information. This gives insight into the potential increase in combat effectiveness realized through the use of an information system.

Modeling and Wargaming of Future Combat Systems at TRAC-WSMR

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Simulation Based Acquisition for future weapons systems entails a cradle to grave program in which modeling and simulation is used in the earliest stages of weapons systems development throughout engineering and manufacturing, test and evaluation, and ending with a simulation that soldiers use for training.

TRADOC Analysis Center-WSMR was truly on the cutting edge of the earliest stages of concept exploration of the Future Combat Systems acquisition program. The Defense Advanced Research Projects Agency (DARPA) and the U.S. Army selected four contractor teams for the Concept Exploration and Design phase of the Future Combat Systems (FCS) program. The Government's intent for the four contracting teams was to develop a virtual FCS using the Army's Simulation and Modeling for Acquisition, Requirements and Training (SMART) concept. The original intent included competition among the teams for the best ideas and concepts for the FCS system. The four teams alternated visits to TRAC-WSMR working with model programmers to ensure their concepts were modeled as close as possible to ensure the most realistic simulations of their concepts. From October 2000 through September 2001 the contractors and TRAC personnel developed, refined, and analyzed the concepts.

The modeling and simulation efforts truly reflected the intent of the of Army's acquisition strategy to use SBA at the earliest stages of acquisition programs. The results of the many runs reflected in changes in the contractor's force compositions, doctrine, TTPs, weapons choices, sensor package choices, etc

EINSTein Model Validation

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The use of Agent Based Models (ABM) to simulate behaviors in combat is gaining increasing recognition and interest across the Operations Research community of both the Marine Corps and now the Army. This paper presents our attempt to "validate" EINSTein (Enhanced ISAAC Neural Simulation Tool) by comparing its outputs to those of another well-known combat simulation model, JANUS. The experiment first establishes the combat effectiveness of EINSTein entities executing a National Training Center (NTC)-type scenario. The scenario is designed to replicate one armored company of 14 "friendly" tanks versus a similar size force of 14 "enemy" main battle tanks. We allowed one set of "friendly" entities to gain knowledge, or "learn," by using the genetic algorithm incorporated in EINSTein. Another set of friendly entities was not allowed to "learn." For both cases, we recorded both the combat results of the EINSTein simulations and the entity actions. These observed actions were programmed into JANUS. For each instance, we compared the combat effectiveness resulting from JANUS to those obtained from EINSTein. The hypothesis of the experiment is that the entities that were allowed to "learn" will have noticeably different behavior and have a significantly better loss-exchange ratio in both EINSTein and JANUS. The paper presents the findings of our analysis and suggests further research areas for using ABM's.

Measuring the Difference in Force Effectiveness Resulting From Changes in Information Systems

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For several years the U.S. Army and Department of Defense have struggled with how to measure the value of battlefield information. Digital information systems have demonstrated the potential to significantly increase the combat effectiveness of our forces, but in order to make procurement, force structure, and basis of issue decisions, we would like to gauge how well proposed information systems perform.

This paper describes a methodology we chose to assess the value of an information system (Force XXI Battle Command, Brigade and Below – FBCB2) to the battlefield decision maker. Our approach focuses on use of the CASTFOREM combat model with emphasis on tying decisions and activities to available information. We discuss use of a detailed communications modeling/information flow capability in CASTFOREM, situational awareness databases at the platform level, decision-making logic, and the incorporation of enhanced Combat Service Support modeling driven by communications and self-determined movement routes.

Coevolving Red and Blue: The Dynamics of Competition

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Typically, operations research analysis of a simulation scenario involves perturbing an agreed-upon base case, in order to perform a sensitivity analysis of a measure(s) of effectiveness to selected inputs to the simulation being run. During this process, the opposing side's inputs are usually held constant. Although this process can yield interesting insight into the scenario at hand, it lacks the ability to analyze what can happen if red and blue inputs are changed in direct response to each other, e.g. as a result of direct competition to each other. We present the idea of coevolution as it pertains to evolving red and blue force parameters in direct response to each other, allowing the simulation of a type of competitive "arms race".

A brief summary of evolutionary computation and theoretical underpinnings of coevolution will be given. Our implemented evolutionary computational software will also be discussed, and preliminary data obtained by coevolving red and blue on one of the Marine Corps Combat Development Command's simulations will be presented and analyzed, with a focus on highlighting key research questions.

Active Protection Methodology Enhancements to CASTFOREM

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There has been heightened interest in active protection, an effort to avoid being hit by an enemy round, since the advent of the Future Combat System. Active Protection Systems (APS) include: warning receivers that detect engagements (missile, laser); soft-kill countermeasures the attempt to spoof or confuse the threat; and hard-kill countermeasures that attempt to destroy the incoming round. Much of CASTFOREM's current active protection methodology is represented as a single user-defined probability. AMSAA is adding quantitative algorithms to CASTFOREM to represent APS in a more realistic manner. The new algorithms dynamically calculate APS effectiveness based on engagement and APS performance characteristics. AMSAA will conduct an analysis of the impact of these changes on the model, both with respect to the performance of the active protection technologies as well as the performance of CASTFOREM itself, and make recommendations about the use of new algorithms in CASTFOREM baseline and COMBAT XXI.

Wargame 2000 Anchoring Study

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The authors recently conducted a model anchoring study to help gain confidence in the Theater Ballistic Missile Defense (TBMD) representations in Wargame 2000, a state-of-the-art command and control simulation under development at the Joint National Integration Center (JNIC) in Colorado Springs, Colorado. Wargame 2000 is the premier human-in-the-loop test bed used by the Missile Defense Agency (MDA) to develop operational concepts and tactics, techniques, and procedures for missile defense. Key TBMD kill chain events in Wargame 2000 were compared against kill chain timeline predictions from the Extended Air Defense Simulation (EADSIM), another model of air and missile defense, using system representations approved by the Army and Navy Program Offices responsible for developing TBMD weapon systems. This paper provides background information on Wargame 2000 and the anchoring study, discusses how the study team overcame difficulties that inevitably arise when trying to compare two models having different underlying assumptions, and presents the final results of the exercise. The Wargame 2000 anchoring study is a success story in model validation and MDA is currently considering expansion of the anchoring program to help gain confidence in the entire family of MDA mission-level models of missile defense.

Information Modeling of Future Technology: Using Complex Adaptive Systems to Model Warfare in the 21st Century

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We describe the modeling of warfare as a complex adaptive system with emphasis on the use of information in combat. Specifically, we address the ability of Agent-Based Models to identify complex interactions that occur with the use of new technologies and how these models can be used in the analysis of potential future weapon systems. We explore the potential gains available in combat modeling from the inclusion of complexity in the modeling process under the guise of modeling the FCS in an agent-based model.

Emergency Preparedness Incident Command Simulation

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The Emergency Preparedness Incident Command Simulation (EPiCS) is a tool for crisis managers and their staffs to exercise command and control in a realistic but simulated environment. EPiCS can be used to train operations command and control personnel, rehearse operations, evaluate operations plans, analyze systems effectiveness, and develop techniques and procedures. EPiCS allows for agencies at local, county, state, and federal levels to exercise their command structure at multiple levels and, at the same time, allow many agencies to interact and develop or exercise procedures for interagency cooperation across jurisdiction boundaries.

Over the last two years, TRAC-WSMR has conducted four EPiCS exercises sponsored by the National Institute of Justice. These exercises have involved various disaster/crisis scenarios including a prison riot, shootings in a school, public disturbances that required mass arrests, and terrorist attacks that triggered a weapon-of-mass destruction (WMD) release in a major city subway. The methods, processes, and results of the project are described. TRAC-WSMR has agreed to conduct overlapping training exercise cycles using EPiCS for the Defense Threat Reduction Agency, (DTRA) to analyze and evaluate site safety response plans and procedures.

The plans and emerging results of these efforts will be outlined and discussed

Multi-Domain Counter-Terrorism Modeling

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A model of terrorist organizations and their activities must address each of the components of a terrorist network - the command nucleus, field cell, group communications, national hosts, sympathizers, and support assets. Together these create a network that enables a small group to conduct guerilla warfare against any target in the world. Modeling our response to these components will require more than traditional interactive or analytic simulations. An appropriate simulation must include the resources and missions of 1) physical assets like the traditional military, special forces, security systems and personnel, and emergency management teams; 2) intelligence collection against domestic and foreign targets; 3) political actions against governmentally sponsored activities; 4) legal actions against non-governmental sympathizers and organizations that support terrorists; 5) financial and economic sanctions targeted at assets belonging to terrorists and nations that host them; and 6) cultural influences on potential terrorist recruits, national sentiment, and media representation. This presentation will discuss potential frameworks for approaching this problem and discovering the algorithms, variables, and relationships for such a system.

Artificial Warfare: Using Agent Based Simulations for the Study of Conflict

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Artificial Warfare is the practice of studying the art of war using computational models of many simple interacting agents following well-defined rules. We calls these agent-based simulations distillations, to reflect their nature as extractions and abstractions of the essential elements of warfare. As part of the Marine Corps' Project Albert, we have developed and sponsored development a variety of distillations. We begin by describing general characteristics of distillations, their relationship to other tools for the study of warfare, and then discuss several of the distillations that are openly available. We also discuss, through examples, several current and potential uses of these distillations, to include, developing intuition, exploring concepts, formulating meta-models, and assisting in the design, analysis and extrapolation of simulation and field experiments. We suggest these tools are useful additions to any analyst's toolbox.

Verification, Validation, and Accreditation of MUVES/S2 for U.S. Army System Evaluations of Ground Combat and Munitions System

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For DoD and service decision makers, technically astute and fiscally sound testing is critical to accurately quantify the survivability and lethality of U.S. ground combat and munitions systems in analysis models and wargames. At the weapon system level, deliberate Army experimentation has been used to fill critical data voids and to develop new model algorithms. These efforts have proven instrumental to incrementally extending the applicability of the tri-service AJEM/ MUVES-S2 analysis code for ballistic survivability/vulnerability/lethality analyses of U.S. Army and foreign weapon systems. These rigorous efforts are providing a critical foundation for analyzing new and emerging weapon system technologies. Algorithm and code advances are also supporting Analyses of Alternatives, U.S.C. Title 10 Live Fire Testing, and DoD 5000.2. In February 2001, the Army Test and Evaluation Command (ATEC) accredited MUVES/S2 for use in system effectiveness evaluations to support the Bradley M2A3 program and for use in shot line analyses, live fire pre-shot predictions, and generating full-view system-level metrics for combat systems and munitions. In December 2001, the Army Research Laboratory presented another compelling MUVES/S2 validation package to ATEC for the BAT program. These efforts will be leveraged to support other munitions in Army development such as GMLRS and P3I BAT. This paper succinctly describes the analytical approach, testing methods, analysis techniques, and modeling advances that are being applied to support the evaluation of ground combat and munitions systems for current and future frontiers.

Revolution in Military Affairs WG-30

Chair: Matt Caffrey, Air Command and Staff College
Co-chairs: Michael W. Garrambone, Veridian Engineering
Michael Bressler, FC Business Systems
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The following abstracts are listed in alphabetical order by principal author.

Modeling Maneuver Warfare Using SEAS

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The goal of military education is to help soldiers understand the nature of war and to teach them how to think logically and creatively about war and during war. Every great military leader understood that success in battle is attributed to well-trained forces. We intend to show that wargaming can play a major role in the course of instructing maneuver warfare techniques. Modeling and Simulation has a pivotal role to play in providing trainers with sound analytical support on training activities designed to teach maneuver warfare. Our study employed Systems Effectiveness Analysis Simulation (SEAS), an AF Toolkit campaign level model. In the past SEAS has been used by senior AF decision makers to determine future space systems policy. Future uses could be to provide analytical support to scenario construction and evaluation of the learning process, for individual or collective training. Our research applies the maneuver warfare principles from the Maneuver Warfare Handbook at the company level and below. It can be used to teach students to make educated decisions through a coherent, logical thought process. Advanced techniques such as unit skills, conducting a specific type of attack, and employing combined arms can be taught and demonstrated. The SEAS model was developed in such a way that it allows for “tactical programming”, which permits the application of maneuver warfare techniques. Most computerized games try to decide “who won” by rewarding “kills”. SEAS, however, is designed to give the decision maker or instructor or student insight into the effects of variables. There is no right answer in maneuver warfare, only timely and logical ones.

Exploring the Validation of Lanchester Equations for the Battle of Kursk

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This research explores the validation of Lanchester equations as models of the attrition process for the Battle of Kursk in World War II. The methodology and results of this study extend previous validation efforts undertaken since the development of the Ardennes Campaign Simulation Data Base (ACSDB) in 1989 and the Kursk Data Base (KDB) in 1996. The KDB is a computerized database developed by the Dupuy Institute and the Center for Army Analysis from military archives in Germany and Russia. The data are two-sided, time-phased (daily), highly detailed, and encompass 15 days of the campaign. This work examines how the various derivatives of Lanchester’s equations fit the newly compiled database on the Battle of Kursk. In addition, the effect of using purely engaged forces, in contact forces, and all forces in parameter estimation is examined.

The Need to Further Educational Wargaming

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Revolution in Military Affairs WG-30

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Objective Force Concept Exploration, A Notional Combat Battalion Engagement

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This study supports Objective Force Combat Battalion concept development and the Army Transformation. It focused on developing, examining, and refining Combat Battalion concepts, and supporting the Future Combat System (FCS) Mission Needs Analysis.

The study scenario facilitates analysis of the Objective Force in combat operations. The scenario provides a context in which an Objective Force Combat Battalion conducts offensive operations in 2015 against a technologically advanced Red force. The engagement was explicitly modeled using the Interactive Distributed Engineering Evaluation and Analysis Simulation (IDEEAS) model. IDEEAS is an entity-based simulation, capable of force-on-force representations, that permits examination of concepts and parametric analysis at the engineering level of detail. Use of the notional battalion force structure allowed O&O concept exploration prior to force design decisions.

This study contributed substantially to the development of the Objective Force, especially with regard to the Unit of Action force design. In addition to the development of concepts, tactics, and insights for future operations the study provided a powerful visualization of this future force. The scenario and base case developed during this study were used extensively by the TRADOC Unit of Action Task Force in their subsequent refinement of the force design. These tools were also used by the Army Medical Department in its transformation wargame effort.

This presentation will provide an overview of the study scenario's purpose, methodology and results.

Wargaming to Support Objective Force Concept Development

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The Objective Force is the realization of the Army vision that was presented by the Chief of Staff of the Army (CSA) in October 1999. The transformation from vision to fielded Objective Force is a process that will occur over several decades. An early and critically important piece of this process is the development of Operational and Organizational (O&O) Concepts. These Objective Force O&O concepts are grounded in the futures work that was done as part of the Army After Next (AAN) project. Futures wargaming has evolved to become an important part in the development of these concepts. In particular, the annual Army Transformation Wargame (ATWG) has emerged as the Army's most visible event for future concept development.

The TRADOC Analysis Center (TRAC) serves as the lead analytic agency for the ATWG sponsored by the TRADOC Deputy Chief of Staff for Doctrine (DCSDOC). This series of wargames is designed to describe, refine and evaluate Objective Force concepts and capabilities over a multi-year period. These wargames provide the Army an opportunity to explore future Army operations at the strategic and operational levels of war in a political/military wargame environment.

This presentation will address the analytic support provided to ATWG 01, Vigilant Warriors. In particular, it will provide an overview of the wargame to include analysis and reporting of the insights for the issues addressed.

Revolution in Military Affairs WG-30

Modeling and Wargaming of Future Combat Systems at TRAC-WSMR

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Simulation Based Acquisition for future weapons systems entails a cradle to grave program in which modeling and simulation is used in the earliest stages of weapons systems development throughout engineering and manufacturing, test and evaluation, and ending with a simulation that soldiers use for training.

TRADOC Analysis Center-WSMR was truly on the cutting edge of the earliest stages of concept exploration of the Future Combat Systems acquisition program. The Defense Advanced Research Projects Agency (DARPA) and the U.S. Army selected four contractor teams for the Concept Exploration and Design phase of the Future Combat Systems (FCS) program. The Government's intent for the four contracting teams was to develop a virtual FCS using the Army's Simulation and Modeling for Acquisition, Requirements and Training (SMART) concept. The original intent included competition among the teams for the best ideas and concepts for the FCS system. The four teams alternated visits to TRAC-WSMR working with model programmers to ensure their concepts were modeled as close as possible to ensure the most realistic simulations of their concepts. From October 2000 through September 2001 the contractors and TRAC personnel developed, refined, and analyzed the concepts.

The modeling and simulation efforts truly reflected the intent of the of Army's acquisition strategy to use SBA at the earliest stages of acquisition programs. The results of the many runs reflected in changes in the contractor's force compositions, doctrine, TTPs, weapons choices, sensor package choices, etc.

Experimentation within the C2 Operation Centers – The Design of a Quick-Draw Time Critical Targeting Team

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Twenty-first century warfare has mandated the gunfighter approach to finding and shooting targets. This means finding, fixing, tracking, targeting, engaging and assessing quickly, before the window of opportunity passes and the speed of decision assures the target no room for shelter. In JEFX 2000 we saw this mechanism paint a coherent picture of the battlespace and formulate C2 responses in a distributed environment. Based upon that picture we constructed a representative team, one-fifth the original size with detailed descriptions of missions, tasks, and informational flows. This structure will be required to manage larger and larger quantities of battlespace information but will do it more quickly in situations where individuals and teams can work out their battle rhythms. This will happen first in a laboratory-like environment which can train, test, assess and improve performance at both the individual and team level. This presentation will describe the assessment approach and methodology employed by the Air Force Research Laboratory's Warfighter Training Research Division (AFRL/HEA) researchers as they observed the C2 operators in the Time Critical Targeting Cell (TCTC) during JEFX 2000. The AFRL/HEA researchers followed a human-factors oriented approach to gain insight into the scope of issues confronting personnel in modern Air Operation Centers. These insights will ultimately drive the C2 operator training requirements and help characterize the individual and team "desired" performance capabilities.

Using Analytical Simulations to Improve Performance of the Warfighter's Simulation

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The robustness of training simulations continues to skyrocket as the power of computers drastically increases in accordance with Moore's Law. Without being careful though, extra burdens demanded by trainers in behavior and fidelity will slow execution times to an unacceptable level. Computer-based simulations, such as the WARfighters' SIMulation (WARSIM), represent systems and forces built from a complex and functional description of military land warfare. The

computerized battlespace that WARSIM model for training joint, corps and divisional commanders and their staffs can become unwieldy in size and functionality. Functionality is key, but next comes performance of the simulation as it portrays combat and its related behaviors, environments and functions. One must assess the performance of the large-scale simulation to determine and justify the appropriate suite of fielded hardware, software and network. Logistical support personnel and training site coordinators need to know whether newly-built and equipped simulation centers will adequately handle the size of a specific training scenario. Proactive efforts to analyze and predict the processes and associated impacts on performance are critical. Using a performance prediction model, the analytical results may help reduce time, resources, and risks associated with the processes of the training system being acquired. The WARSIM Performance Emulation Model shows and predicts how a training simulation will perform. The results from the findings help guide the development of the actual WARSIM system components. This paper describes the use of a commercial off-the-shelf simulation package to emulate WARSIM and discusses the potential application to other simulation models for applying analytical tools that predict performance.

Conventional Weapon Systems and Homeland Security: A First Look

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As part of the immediate response to the events of 11 September 2001, two PERRY class frigates and one SPRUANCE class destroyer sortied from their respective homeports and took up assigned defensive positions inside Puget Sound. The SPRUANCE was assigned to defend NAVSUBASE Bangor, and the ballistic missile submarines based there. The two PERRY's were assigned to defend metropolitan Seattle, and NAVSTA Bremerton, and the nuclear capable shipyard there. Air cover for the region was provided by Air Force elements based out of Portland, OR. The problem with this assignment was not the obvious beneficial psychological boost to the local civilian population, but rather the capability of the sensors and weapon systems on each if these platforms to defeat the perceived threat. Specifically, it is the authors contentions that these platforms, while designed for and capable of conducting combat against conventional targets, were ill-equipped to deal with a) multiple attacks by commercial aircraft, b) car bomb equipped ferries, or c) other asymmetric physical threats. This paper examines why this is so, and provides some recommendations on future weapon systems to counter these threats.

Joint Data Support

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Joint Data Support (JDS) is a component of the Joint Analytic Model Improvement Program (JAMIP), under the administration of the Office of the Secretary of Defense (Program Analysis and Evaluation), with funding from the Joint Staff (J-8). The charter of JDS is to provide and manage data for DoD analytical studies along a broad customer base, including both studies using "JAMIP" simulations (MIDAS, TACWAR, ITEM, ELIST, VIC, and EADSIM), and those using other decision support processes (e.g., the DYNAMIC COMMITMENT seminar wargame). The charter of JDS also includes support for development and fielding of the Joint Warfare System (JWARS).

JDS operates according to a rigorous yet flexible Study Support Process. This brief will provide details of that process, including JDS principles and challenges. There will be several recent examples of JDS-provided data support. A large portion of this brief will cover data support for the development and fielding of JWARS.

Artificial Warfare: Using Agent Based Simulations for the Study of Conflict

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Artificial Warfare is the practice of studying the art of war using computational models of many simple interacting agents following well-defined rules. We calls these agent-based simulations distillations, to reflect their nature as extractions

and abstractions of the essential elements of warfare. As part of the Marine Corps' Project Albert, we have developed and sponsored development a variety of distillations. We begin by describing general characteristics of distillations, their relationship to other tools for the study of warfare, and then discuss several of the distillations that are openly available. We also discuss, through examples, several current and potential uses of these distillations, to include, developing intuition, exploring concepts, formulating meta-models, and assisting in the design, analysis and extrapolation of simulation and field experiments. We suggest these tools are useful additions to any analyst's toolbox.

Generating Surprise: Using Natural Heuristics in the Search for Novelty

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Any non-trivial combat simulation is characterized by very large input spaces, where the input may be in the form of simple parameter settings to more complicated data structures. Each "point" in this space can be viewed as a possible solution to a problem confronting the agents in the simulation. We can explore this space looking for novel or surprising solutions using a class of algorithms called natural heuristics. Natural heuristics are optimization techniques inspired by analogy to phenomena in the natural world. The heuristics include such algorithms as simulated annealing, immune algorithms, and genetic algorithms. As part of the Marine Corps' Project Albert, we are developing a new set of techniques based on these natural heuristics to search for novelty in these large simulation spaces. We will discuss our first experiments applying this new methodology to agent-based simulations in the context of terrorism questions in tactical settings.

Simulation-based Technology and Investment Planning Experiment (STIPE) Campaign Modeling as Applied on the SensorCraft Technology Assessment

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The goals of STIPE are to reduce the time and cost for developing and maturing promising Uninhabited Air Vehicle (UAV) technologies, to integrate the technologist and the warfighter into the Science and Technology (S&T) acquisition process, and to provide analytical input into the Air Force S&T planning process. STIPE combines engineering-level modeling, design and analysis tools, mission- and campaign-level simulations, and cost analysis tools in a simulation environment to provide analytic information to support investment decisions in the Science and Technology arena. This simulation environment will provide the capability for researchers to evaluate the impact of different UAV technologies in a warfighting environment, providing a link between AFRL technologies and warfighter mission needs.

The STIPE simulation environment is being applied on the SensorCraft Technology Assessment as a proof of concept. AFRLs' SensorCraft initiative is an advanced multi-sensor UAV for standoff ISR. This presentation focuses on the campaign level analysis performed in support of the SensorCraft Technology Assessment. The goal of the campaign analysis is to provide operational measures of merit for return on investment (ROI) analysis to identify promising candidate SensorCraft concepts. The variables derived from the candidate technologies include the basing concept, air vehicle endurance, air vehicle RCS, mean time between critical failure (MTBCF), mean time to repair (MTTR), ground moving target indicator/tracker (GMTI/T) performance, spot synthetic aperture radar (SAR) performance, and air moving target indicator (AMTI) performance. The primary measures of merit at the campaign level are kills by target type and campaign duration required for operational task objectives.

Chair: Robert L. Albright, MANSCEN DCD
Co-chairs: N. Lori Evans, ACC/DRYS;
Dave Hoffman, TRAC – WSMR;
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Robert Meyer, ASC/SMJ, JMASS JPO;
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The following abstracts are listed in alphabetical order by principal author.

Joint Virtual Battlespace (JVB) – A Concept Evaluation Environment

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"The Army *must* change." So says LtGen John Riggs, Director of Objective Force Task Force. But how should it change? To understand how best to transform the Army to fulfill the defense needs of the nation in the 21st Century, there is a requirement for detailed, yet broad analysis of proposed concepts. Broad analysis must be done to insure the applicability of concepts and developmental systems in the context of likely and plausible future military scenarios. Yet the analysis must also dive deep into the details of information flow, communications, situational awareness, weapons and survivability, and at the same time support development of a wide family of new systems (Future Combat System) and others. Stovepipe analysis of a single weapon system, using a set of standard standalone simulations, will not meet this requirement. Instead, the Army and Joint Precision Strike Demonstration are building an evaluation environment called Joint Virtual Battlespace (JVB) using the SMART (Simulation & Modeling for Acquisition, Requirements and Training) process. JVB is using distributed simulation to incorporate the best existing models and simulations as needed for evaluation of C4ISR warfighting concepts. The emphasis in JVB is on integrating existing tools, not building new components unless absolutely necessary to bridge gaps between legacy models. The environment is tailorable to analysis needs by incorporating various tools when they are needed to answer specific questions. And is this not how analysis should work? First formulate the question, and only then select or build a tool to help answer it.

The current focus of JVB is to support Objective Force and Future Combat Systems analysis of alternatives for TRADOC Analysis Center. For this effort, JVB is gathering a variety of models and simulations from STRICOM, Department of Energy's Sandia National Laboratory, the Army Research and Development Engineering Center, and other agencies and contractors. In the coming years, JVB will provide a robust, tailorable, and focused tool set to answer the question "How should the Army change?"

Food for Feedback: An Operations Analysts Reference on Wartime Data Collection

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Approved abstract unavailable at printing.

Pythagoras: The Newest Member of the Project Albert Family

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Pythagoras is a new Agent-based distillation, being developed to supplement/complement the Project Albert family of distillations, which include Mana, Socrates and Isaac. Pythagoras brings new capabilities to this family, such as Soft Decision Rules, Dynamic Sidedness, Behavior-Change Triggers and Non-Lethal Weapons. Soft Decision Rules create

instances of Agents from the same Agent class that have behaviors that are unique from one another. Dynamic Sidedness allows Agents to change sides as a function of actions and events that they encounter. Behavior-Change Triggers allow Agents to change their behavior as a function of actions or events. Non-Lethal Weapons, not only cause suppression, but may also change the sidedness or affiliation of an Agent. Pythagoras Scenarios include a Cave Search scenario in which Marines look for an elusive Agent. A Peace Keeping Scenario has also been built in which Marines use short-range non-lethal weapons (like leaflets or food) to sway the affiliation of villagers, while an enemy is broadcasting propaganda with an indirect fire non-lethal weapon (a bull horn) to sway them against the Marines. Pythagoras is written in JAVA, and is hosted at the Maui High Performance Computing Center, where it is available for data farming - executing large numbers of repetitions of parametric runs to identify areas of unexpected behaviors and non-linear results in a co-evolving landscape.

Strategies and Techniques for Automation of Data Management and Reduction to Support Real - Time and Near Real-Time Data Analysis.

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The JT&E programs like many other test and evaluation programs collect large quantities of data to answer measures of performance (MOPs), measures of effectiveness (MOEs), and program issues. Often subject matter experts and the analysts are called upon to provide short notice or quick-look analyses and summaries of the data, MOEs, and MOPs. Limited time, personnel, and resources can make this a rather daunting task. Even supporting interim and final reports can present a challenge to the analysis group. With the advances in computer software, a well-designed data management and analysis program can make report generation and quick-look support quite manageable. The key to efficient use of computer resources is selecting the appropriate software for the task at hand. i.e. using Access for data management, relationships, and merging data while using the SPSS statistical program for advanced statistics and presentation efforts.

The Joint Close Air Support (JCAS) Joint Test Force (JTF) has a very complex model, which includes over 260 MOPs and MOEs, to describe the joint close air support process. To manage the data and automate the data analysis, a relational database was developed using Microsoft Access. Access was able to mathematically model the JCAS process by providing relational links between the tables (sub processes). These relational links also provided the capability to merge test conditions with appropriate test measures. The power of Access permitted real-time updates of test measure data and quick-look analysis of test measures and test conditions. Through visual basic programming and export of test measure data to Excel, near real-time readouts of all test measure values and some descriptive statistics were available with breakouts by individual battle or for the cumulative test program. Access was also used to provide preliminary marking of records each test measure for analysis. This relational database with marked records was imported into SPSS, a statistical analysis package, for more detailed descriptive analysis, ANOVA analysis, and sensitivity studies. Automation and macros were also used in the SPSS programs to reduce development and analysis time.

Embedded Simulation System for SMART

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The U.S. Army's Tank-Automotive Research, Development and Engineering Center (TARDEC) Embedded Simulation (ES) team, has developed an Embedded Simulation System that interfaces with advanced vehicle hardware and software as part of the Inter-Vehicle Electronics Suite (IVES) Science and Technology Objective (STO). The ES system allowed the IVES STO to field test advanced concepts such as Indirect Vision Driving, Drive-By-Wire, Voice Recognition, 3D Audio, Head Tracking and advanced crew station design using simulation to provide stimulation to crewmen. Technologies that were simulated to provide workload analysis for the two- man crew included Automatic Target Recognition (ATR), Automatic Target Tracking (ATT), C2, integrated OPFOR and Friendly CGF and Battlefield Visualization.

A Novel Approach to Agent-Based Modeling: Patterns and Behaviors as Building Blocks

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In the past, the art of combat modeling and military utility analysis has been plagued by three persistent factors: 1) there is no "unifying theory of combat" to support a first principles approach to warfare modeling; 2) there are no validated conops, tactics, strategies for future systems operating in hypothetical scenarios; and 3) general-purpose systems modeling languages do not adequately capture spatial-temporal interdependencies and nonlinear processes inherent in warfare. Symptoms of this problem include proliferation of combat system MOPs/MOEs/MOOs/MOUs, obscure cause-and-effect mechanisms embedded within large and complex simulations, and oversimplification of system models in order to fit the tools on hand. This presentation introduces the General Agent Interaction Model (GAIM), a modeling paradigm meant to address these deficiencies, and its prototype implementation, *AgentSIM*, written in the *Mathematica©* programming language. GAIM provides a conceptual framework for constructing, evaluating, and analyzing agent-based models in terms of standardized behavioral components and agent-target interactions. *AgentSIM* provides an integrated environment for documenting, coding, executing, and presenting small-scale GAIM applications using *Mathematica*'s© symbolic programming and notebook interface technologies. The principles of modularity, flexibility, and traceability inherent in the GAIM/*AgentSIM* approach to modeling are illustrated in the context of a notional SEAD mission analysis template.

Teaching Strategic Center of Gravity Analysis Through Learning Agent Technologies

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Students at the U. S. Army War College are discovering new insights into Center of Gravity analysis. They both teach and learn from an intelligent agent software program called Disciple, created in the George Mason University Learning Agents Laboratory (LALAB). This paper will describe a multi-faceted research and development effort that synergistically integrates research in Artificial Intelligence, Center of Gravity analysis, and practical deployment of an agent into Education.

A Hybrid Tabu Search/Set Partitioning Approach to Tanker Crew Scheduling

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Aerial refueling is a crucial component of modern day operations. A vital part of this refueling process is the individual tanker crews. Constrained by the number of crews available, the USAF must find ways to schedule them efficiently.

This paper details solving the tanker crew scheduling problem with a hybrid tabu search/set partitioning optimizer. We show the synergistic use of the two approaches. The tabu search metaheuristic acts as a column generator for the set partitioning optimizer, while the set partitioning optimizer provides a vocabulary building mechanism for the tabu search.

We show how the model may be used as an analytical tool, as well as an operational scheduler. Statistical results show the increased performance of the hybrid over the existing USAF tool and the tabu search working alone. The results also show how problem characteristics affect the solution process.

Analytic Support for Courses of Action Development During Crisis Action Planning

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US Joint Forces Command Joint Warfighting Center (USJFCOM JWFC) is working to improve Courses of Action (COA) analysis and use of staff planning tools during crisis action planning (CAP). To maintain relevancy in current and future crisis responses, Joint Task Force (JTF) planners must be able to consider not only the traditional military actions to achieve strategic and operational objectives, but they must also analyze other elements of power (diplomacy, information, and economic) and consider their interactions. Modern Crisis Action Planning requires JTF staffs to conduct multiple detailed analyses of greater complexity in ever-shortening timelines. The majority of current models, simulations, and automated decision aids currently fielded do not adequately support course of action analysis during CAP at the joint operational level of war. They tend to be tactical, service-centric, attrition-based, force-on-force systems that fail to capture contemporary crisis dynamics. There is an immediate need for analytic tools to support crisis action planning courses of action development and selection at the operational level.

Combat Scenario Development and Gaming Level Editing: A Comparison of Procedures

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The development of scenarios for combat models and the creation of levels (the gaming term for scenarios) for the civilian gaming community are very similar activities yet they differ significantly in terms of purpose and procedures. These differences have produced two similar product development techniques, each evolving somewhat independently over the last thirty years. These processes provide significant overlapping functionality yet each has specific strengths and limitations. After analyzing the methods of combat model scenario development and gaming level creation for three state of the art and emergent models, we compare and contrast the current state-of- the-art in these communities, with the objective of identifying potential areas for enhancing each procedure by exploiting the advantages of the other. Harvesting some of these capabilities from the gaming community could help to reduce combat model scenario development time and improve modelers' abilities to demonstrate scenarios to the chain of command.

Assessing Effects of Enhanced Fidelity for Ground Vehicle Mobility in Combat Models

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As computer systems exhibit greater computing power, they provide combat model developers the capabilities to enhance the fidelity of their simulations by improving the fidelity of underlying algorithms. Movement, such as ground vehicle movement, is one of the basic battlefield functions and is portrayed at differing levels of fidelity across M&S. Ground vehicle movement is limited by the terrain/environmental factors present in reality, but this fact is not necessarily reflected in current simulations. The need to account for such effects has been acknowledged by the community and is being incorporated in developing simulations. As simulation fidelity is enhanced, however, it is also important to address the question of what increased or decreased fidelity representation buys the user/analyst.

This paper will address effects of improving ground vehicle mobility representation in entity-level M&S by incorporating mobility limiters, utilizing the recent integration of the standard mobility application programmers interface, STNDMob API, with COMBAT^{XXI}. The development and integration were conducted largely by the US Army Engineer Research and Development Center and the US Army TRADOC Analysis Center – White Sands Missile Range.

COMBAT^{XXI} is the Army's next-generation brigade and below entity level analytical model. The standard mobility application programmers interface, STNDMob API, allows entity level models to use terrain limited speed factors and is based on the Army's standard mobility model, NATO Reference Mobility Model (NRMM). This integration has revealed some potential impacts on simulation outcomes resulting from dynamically limiting the speed of vehicles and restricting areas of operation based on environmental conditions versus utilizing command ordered or static speeds and will form the basis for the study.

Resampling Statistics and Designed Experiments

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For those of us that teach statistics, one result is clear: most people find the subject difficult and confusing, leading to either failing to apply the correct methods in real world problems or failing to apply statistics at all. Dr. Julian Simon, a founding father in the field of Resampling Statistics (1967), believes that the inherent difficulty in statistics lies in the difficulty of the concepts addressed.

Dr. Bradley Efron, of Stanford University, independently developed a general resampling method he called the "bootstrap", in the 1970s. The basic idea is that all the information we have about a sample is contained in that sample; we have no a priori knowledge that the sample came from a specific type of distribution. Since that's true, let's treat the sample as the proxy universe that all samples come from. Everything else in bootstrap follows from that simple idea. Jerome H. Friedman, a Stanford resampling statistician said: "Eventually, it will take over the field, I think.'" (*New York Times*, Nov. 8, 1988, C1, C6)

We are in the process of determining whether Dr. Friedman is correct. Design of Experiments has revolutionized testing at the 53rd Wing, Eglin AFB, but we continue to struggle with generating enough practitioners of the method to address all the tests undertaken by the Wing. The chief difficulty lies in teaching the foundations, mechanics and extensions of the Analysis of Variance (ANOVA) to analyze the sample (now 2-3 weeks). This paper represents a status report on a work in progress – determining how the attractive aspects of resampling statistics can be applied to the multivariate problems of experimental design. We will summarize the background of resampling statistics, and the classical and resampling approaches to analyzing multivariate data.

Sample Size Estimation Using Bootstrap

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One typically needs an estimate of how many samples should be collected, even before a test starts. Sample size calculations for factorial tests typically make distribution assumptions that may not be warranted. We will approach sample size calculation using bootstrap, a distribution-free technique, and compare it to more common approaches.

Using Resampling for Design of Experiments With Missing Data

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The usual approach to missing data in factorial experiments is to estimate the level of the missing treatment by fitting a model to the existing data and using this calculated value as a surrogate. Here, we show an alternative using resampling. We compare the two approaches and discuss the differences.

An Integrated Gaming System for the Army Transformation Wargame

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The Integrated Gaming System (IGS) is an integrated, model-supported gaming system consisting of a set of tools linked to a common database and capable of supporting a wide range of gaming requirements. The U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC) provides contract oversight management for the development and use of the IGS in support of the TRADOC Deputy Chief of Staff for Doctrine (DCSDOC). The Wargaming and Futures Directorates within DCSDOC are the program and systems' sponsors.

The IGS is a Booz-Allen & Hamilton (BAH)-developed wargame automation system that fulfills the functional requirements of the Wargame Architecture (WGA) concept, which developed out of requirements identified by DCSDOC beginning in 1996. DCSDOC identified these requirements while preparing for a series of wargaming events that supported the Army After Next (AAN) future studies effort. The purpose of the IGS is to perform the functions of the WGA in support of TRADOC's Army Transformation wargame, study, and research efforts. This presentation provides an overview of the IGS system, its components, and its use during last year's Army Transformation Wargame - Vigilant Warriors 01.

An Application of Distillation Modeling to Studying the Enemy Within

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Ongoing research into how to develop better maneuver warriors through the application of distillation modeling and data farming to questions regarding conflict is sponsored by the USMC's Project Albert. MITRE is supporting Project Albert's effort to develop tools to explore questions using a synthesis of both new and existing methods. The approach is to use a series of new models/analytic tools, multi-disciplinary teams, and the scientific method to explore questions; exploit advances in computing power and visualization tools; and utilize the meta-technique of "Data Farming" to go beyond single point estimate and look at questions from the perspective of many data points. This presentation describes a set of recent applications addressing questions relating to "the threat within" including martyr-minded enemies, sabotage and corruption, incompetence, and false intelligence. A demonstration of the distillation tools employed in this research as well as data associated with this study will be discussed.

Standard Nomenclature Database & Website

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Approximately 11 years ago the TRADOC Analysis Center (TRAC) took the initiative to develop a "standard nomenclature library/dictionary" to facilitate the exchange of characteristics & performance (C&P) data with our customers and data providers. This "weapon system" C&P data is required to feed TRAC combat simulations run in support of TRAC studies. TRAC stores this C&P data in Functional Area Databases where it is indexed by the "standard component names" (e.g., platform, weapon, mount, munition, etc.). These standard names are stored in the TRAC developed Standard Nomenclature Database (SND). Previously inconsistencies in these component names like T-72, T72, T/72 or T 72 severely complicated the "electronic" exchange of data. Since TRAC does not have the manpower or diverse expertise to solely maintain the ever-growing SND, help is solicited via the TRAC (SIPRNet) website which went into operation in August 1999. Registered website customers are encouraged to recommend nomenclature additions, deletions and modifications in areas of personal expertise. TRAC, AMSAA, NGIC and CAA are working toward nomenclature compliance within their respective C&P databases and it is anticipated that sometime in the future AMSAA will assume responsibility for the SND and supporting website, but currently it remains under TRAC control. My presentation will also briefly touch on our Functional Area Databases and a couple of downloadable software applications (most notably the TRAC Automated Data Request System; TRACDRS) our customers use to submit consistently formatted, standard nomenclature-compliant data requests.

An Agent-Based Modeling Approach to Measuring the Value of a Proposed Information System

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For several years the U.S. Army and Department of Defense have struggled with how to measure the value of battlefield information. Digital information systems have demonstrated the potential to significantly increase the combat effectiveness of our forces, but in order to make procurement, force structure, and basis of issue decisions, we would like to gauge the extent to which these systems increase combat effectiveness. This paper describes a methodology we chose to investigate whether an agent-based-model (ABM) could be used to suggest appropriate behaviors for a combat force equipped with a proposed information system such as Future Battle Command Brigade and Below – FBCB2. The decision agents within the model will use the information about enemy forces, friendly forces, and terrain provided by the proposed information system to adjust the friendly course of action to the updated situation. Our methodology is a three-step process. We first execute simulation runs using an existing dynamic study scenario and evaluate the results of these runs. In the second step, we transfer the terrain, units, and course of action from the existing dynamic scenario to an ABM with intelligent agents that will refine the course of action genetic algorithm by generating new unit positions and routes based upon the current situation. In the final step, we substitute the ABM developed course of action and behaviors back into the dynamic study scenario and execute another set of simulation runs. The performance of the friendly force using the proposed information system and ABM generated behaviors may be compared to the performance of the friendly force which failed to take advantage of current information. This gives insight into the potential increase in combat effectiveness realized through the use of an information system.

The Use of Design of Experiment During Tactics Development

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The events of 11 September will profoundly affect military affairs, at every level from strategic to operational to tactical. The fact is, all activities in a healthy military—including tactics, doctrine, weapons acquisition, joint operations, intelligence, and combat support—should be in a constant state of positive change. That is because the factors that affect military affairs are in a constant state of flux. These factors include changes in the threat's tactics and weapons, changes in the arenas in which we employ, and the emergence of new technologies creating potentially new capabilities in our weaponry. History, in fact, has shown that a failure to accommodate changes in the threat, the environment, and new technology leads to disastrous results in combat.

The emergence of a new level of international terrorism, especially as a direct and significant threat to the security of the continental US, is a perfect illustration of a factor that will demand changes in military tactics, doctrine, and weaponry. We should expect to see, therefore, changes in strategy, operational doctrine, tactics, and weapons over the near future. We may also see an increase in the funding for these endeavors. However, we can be sure that in any case, resources for testing will always be constrained. There will always be a need for efficient as well as effective testing.

All of the services have well established processes in place to develop new tactics in response to changes in the threat, the arena, and the available technology. In the Air Force, this process is most obvious during Tactics Development and Evaluations, or TD&Es. This form of operational testing typically involves operationally representative US platforms, employed by combat qualified crews, in realistic exercises, against representative live threats, capitalizing on digital computation for range support and weapon simulations. In fact, these exercises are run as close to combat realism as possible. For air-to-surface tactics, live ordnance is often employed. For air-to-air tactics, computer simulations substitute for live missiles and guns. Various tactics are proposed and then flown in these realistic scenarios. Results are collected in the form of both objective, quantitative data and subjective evaluations from the participants. Because the exercises are quite complex and involve many players and a large number of variables (some controllable, some not) affecting the outcome, and because the usefulness of tactics is often more opinion than fact, we have typically relied heavily upon the subjective post-mission assessments of the participants, and less on objective, quantitative analysis.

The use of Design of Experiment (DOE) as a methodology for setting up tests and evaluating the results has been essentially non-existent within Air Force tactics development. Even when offered to test managers, arguments against the use of DOE are many: DOE will overly constrain the participants in realistic, operational testing; the scenarios are overly

complex for DOE; tactics are not suitable for numerical analysis; DOE demands too many resources. Recently, there has been a movement within the Air Force to utilize DOE during operational testing, though significant resistance remains.

The truth is, DOE has been used for many years on very complex experiments in the civilian sector. Its application to military experiments, including TD&Es, is clearly apparent. In fact, it is during the most complex kinds of experimentation, like tactics development, where DOE has the greatest potential to deliver more and better knowledge about the phenomena occurring, to provide quality answers using fewer resources, or to yield more information for the same resources. Nevertheless, we still face the same arguments.

The purpose of this study was to demonstrate the utility of DOE in the tactics development arena in order to dispel the myths that DOE is either impractical or ineffective. The study included both experimental design (for example, the use of factorial experiments, randomization, independent trials) and analysis (the use of ANOVA). The study utilized a Microsoft Excel-based simulation of aerial combat—a relatively simple, but nevertheless high fidelity model of aerial combat engagements involving as many as 8 versus 8 players, using notional but realistic event probabilities obtained from subject matter experts. The model includes such events as threat detection, hostile declaration, and effective missile employment. After a significant amount of verification using subject matter expertise, the model was given favorable reviews. We then set up a notional tactics development evaluation, with a number of control factors typical of TD&Es (threat electronic warfare, friendly support assets, threat tactics options, and friendly rules of engagement) to assess two notional friendly tactics (Option A and Option B). Our response variables included such typical air-to-air success measures as kill ratios, threats killed, and friendlies lost.

The study used a series of engagement simulations to compare the results obtained using sound DOE principles against the most typical methodologies currently used: "one-factor-at-a-time" and "best guess." The study demonstrated the shortcomings of these techniques in comparison with both the efficiency and the effectiveness of results obtained through DOE.

By using an inexpensive, simple, but high fidelity simulation of aerial combat, we were able to demonstrate the value of DOE in the complex arena of tactics development. The fact is that in any tactics exercise, there are always constraints placed on the participants, generally in the control factors that we chose for our model (rules of engagement, friendly support, threat tactics, and so on). We have demonstrated that is possible to control the engagements at the scenario level, without constraining the maneuvering and tactical decisions of the participants. Using the scenario-level elements as our control factors, and by assessing results using traditional measures of effectiveness, we were able to demonstrate the utility of DOE in spite of the complexity of the experiment, thereby countering the traditional arguments against DOE. DOE was clearly able to provide more and better knowledge about the relationships between the control variables—especially the friendly tactics option—and the response variables, while using fewer trials that expend valuable test resources.

The result of this study is a method of demonstrating the utility of DOE during the most complex of tests, as the Air Force embarks on a program to make it the methodology of choice for all Air Force testing.

AMSAA Infantry MOUT Simulation (AIMS)

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AMSAA is developing the AMSAA Infantry MOUT Simulation (AIMS) to support Army analysis on evaluating infantry soldier/unit performance in a MOUT environment. This modeling effort is designed to fill a key Army MOUT modeling and analysis void. Key to the AIMS development is designing the soldier/unit MOUT behavior. The effort is state-of-the-art in its use of object-oriented programming using the Joint Model and Simulation System (JMASS). This project will involve development of individual soldier behaviors and activities as well as his function as part of a unit when carrying out missions and tasks using the various weapons and equipment assigned to him. AIMS is being designed to simulate soldier behaviors to respond to the following scenario conditions:

- Ambush/counter-ambush
- Sniper/counter-sniper
- Preparation/penetration of obstacles
- Employing support Fire
- Defending sector
- Defeat/neutralize attack
- Containment of prisoners
- Evacuation of wounded

AIMS is undergoing a proof-of-principle study to support simulation VV&A. It is envisioned that AIMS will become the basis for the Army's item-level and small unit engagement analyses to support requirements generation, materiel evaluation, and Analysis of Alternative studies.

Using Analytical Simulations to Improve Performance of the Warfighter's Simulation

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The robustness of training simulations continues to skyrocket as the power of computers drastically increases in accordance with Moore's Law. Without being careful though, extra burdens demanded by trainers in behavior and fidelity will slow execution times to an unacceptable level. Computer-based simulations, such as the WARfighters' SIMulation (WARSIM), represent systems and forces built from a complex and functional description of military land warfare. The computerized battlespace that WARSIM model for training joint, corps and divisional commanders and their staffs can become unwieldy in size and functionality. Functionality is key, but next comes performance of the simulation as it portrays combat and its related behaviors, environments and functions. One must assess the performance of the large-scale simulation to determine and justify the appropriate suite of fielded hardware, software and network. Logistical support personnel and training site coordinators need to know whether newly-built and equipped simulation centers will adequately handle the size of a specific training scenario. Proactive efforts to analyze and predict the processes and associated impacts on performance are critical. Using a performance prediction model, the analytical results may help reduce time, resources, and risks associated with the processes of the training system being acquired. The WARSIM Performance Emulation Model shows and predicts how a training simulation will perform. The results from the findings help guide the development of the actual WARSIM system components. This paper describes the use of a commercial off-the-shelf simulation package to emulate WARSIM and discusses the potential application to other simulation models for applying analytical tools that predict performance.

Transformation Through Modeling and Simulation: The Need for Composability

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An Embellishment to Gaussian Power Spectral Density Based Noise

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Providing Authoritative Equipment Characteristics

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Obstacle Crossing Performance of Vehicles

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Obstacles can disrupt, impede, and otherwise influence the outcome of military operations, understanding when and how fast an obstacle can be crossed is required to increase Army model and simulation fidelity. Obstacles other than minefields, such as ditches, berms, cuts and fills, craters, etc can be either natural, man made or reinforced, and depending on vehicle capabilities, these obstacles may be crossable, but at a greatly reduced speed. Obstacle crossing speed is also an issue when comparing performance between wheel and tracked vehicles, additionally the performance of small robotic vehicles must also be considered in emerging simulations. This presentation describes current efforts by the Engineer Research and Development Center (ERDC) to enhance vehicle speed predictions during an obstacle crossing in a SAF environment.

The NATO Reference Mobility Model II (NRMM II) is an Army standard model for determining vehicle mobility performance, primarily by predicting maximum vehicle capable speeds. The effect of a linear obstacle on maximum speed is determined by using two look-up tables. The first is a table of average and maximum (resistance to motion) forces and minimum clearances based on standard obstacle descriptions. If the minimum clearance is greater than the vehicle clearance, the maximum force is used to determine if there is enough available traction to cross the obstacle. If either the clearance or maximum traction tests fail, NRMM II predicts no-go. Otherwise, the average force is added to the total resistance, which is used to calculate the maximum vehicle capable speed across the obstacle. The second table contains vehicle speed versus obstacle height and is used to limit speed due to vehicle and driver acceleration tolerance (2.5g). These tables are in the individual NRMM II vehicle data files, and are produced using 2-dimensional vehicle dynamics software (OBSMOD and VEHDYN II).

The extraction of this information, obstacle description requirements, the implementation of this high resolution data/model into a lower resolution SAF environment are discussed.

The ES system has also been integrated with AMC RDEC Federation. The RDEC Federation provides full spectrum modeling and simulation services to any customer. Full spectrum ranges from engineering level models through virtual prototypes onto battlefield simulations. All models are validated to the system they represent through close interaction between the modeler and system developer. All simulation scenarios are based upon realistic circumstances, run real-time, and generate semi-automated forces as required. Each RDEC (and ARL and STRICOM) brings a robust suite of supported models within their area of technological and subject matter expertise. These areas include mobility, missiles, armaments, communications, aviation, target acquisition sensors, survivability, vehicles, and command and control. By, utilizing environment servers provided by the Joint Virtual Battlespace (JVB) environmental conditions would be able to be used to provide realistic testing of the above models. The use of ES System allows the customer to evaluate advanced concepts in the latest crewstation designs with the latest interfaces.

The ES system is being enhanced and used as part of the Crew integration and Automation Testbed (CAT) Advanced Technology Demonstration (ATD) and Robotic Follower ATD in support of the FCS program. A field demonstration is planned for 2003.

Middleware Advantages in a Real-Time Tactical Environment

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The future of the military is relying on Commercial off the Shelf (COTS) products to address real time military requirements. These computing challenges within the Navy were one of the motivating factors for the creation of the High Performance Distributed Computing (HiPer-D) prototyping effort. The High Performance Distributed Computing (HiPer-D) laboratory is a real-time laboratory located in Dahlgren Virginia where multiple Aegis tactical system platforms are prototyped in order to demonstrate proofs of concepts with respect to advanced computing architecture and algorithm development using COTS technologies. The focus of this brief is to describe the advantages and lessons learned of utilizing middleware such as Ensemble and Network Data Delivery Service (NDDS) which allows code portability, open architecture design and risk reduction of extraneous errors. The example that will be used to demonstrate the advantages of the non-intrusive nature and portability of object code will be the integration of an Engagement Coordination scheme that communicates with each platform's Weapon Control System (WCS).

Effect-Based Operations (EBO) Analysis of Counter Terrorism using Agent-Based Modeling

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We present a methodology using existing tools from Project Albert to analyze counter terrorism (CT). Project Albert is a research and development effort of the Marine Corps Combat Development Command (MCCDC) to assess the general applicability of the study of complex adaptive systems (CAS) to warfare, and to provide new methodologies for investigating the results of running such models, and incorporating those results with other, more traditional, methods of analysis. Two Project Albert tools used in this CT analysis are Socrates, an agent-based model, together with a Generative Analysis (GAn) search heuristic.

Our analysis frames CT questions to be answered and poses candidate issues to counter terrorism. We examine terrorist behaviors and personalities modeled in Socrates and address the relationships among Red, Blue, and other agents. The GAn search heuristic starts by generating a set of possible solutions. These solutions are then evaluated by Socrates. The best solutions with respect to desired “effects” are saved. The next set of trial solutions is then generated and the process is repeated.

We apply EBO to select the “best of the best” from the set of best solutions. The best solutions from the GAn heuristic search were generated trying to optimize over a set of desired effects (or goals). Using the concept of EBO, we pick from the best solutions those that are what Dr. Alfred Brandstein calls “more interesting” - that is, they are more robust, or achieve the effect in some novel fashion. Finally, we analyze the more interesting solutions to gain insights for the CT mission, e.g., find anti-solutions, i.e., what Red comes up with to counter Blue’s best.

Human Behavior Representation in an Agent Based Model

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Computing Advances in Military OR WG-31

Artificial Warfare: Using Agent-based Simulations for the Study of Conflict

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Artificial Warfare is the practice of studying the art of war using computational models of many simple interacting agents following well-defined rules. We call these agent-based simulations distillations, to reflect their nature as extractions and abstractions of the essential elements of warfare. As part of the Marine Corps' Project Albert, we have developed and sponsored development of a variety of distillations. We begin by describing general characteristics of distillations, their relationship to other tools for the study of warfare, and then discuss several of the distillations that are openly available. We also discuss, through examples, several current and potential uses of these distillations, to include, developing intuition, exploring concepts, formulating meta-models, and assisting in the design, analysis, and extrapolation of simulation and field experiments. We suggest these tools are useful additions to any analyst's toolbox.

Generating Surprise: Using Natural Heuristics in the Search for Novelty

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Any non-trivial combat simulation is characterized by very large input spaces, where the input may be in the form of simple parameter settings to more complicated data structures. Each “point” in this space can be viewed as a possible solution to a problem confronting the agents in the simulation. We can explore this space looking for novel or surprising solutions using a class of algorithms called natural heuristics. Natural heuristics are optimization techniques inspired by analogy to phenomena in the natural world. The heuristics include such algorithms as simulated annealing, immune algorithms, and genetic algorithms. As part of the Marine Corps' Project Albert, we are developing a new set of techniques based on these natural heuristics to search for novelty in these large simulation spaces. We will discuss our first experiments applying this new methodology to agent-based simulations in the context of terrorism questions in tactical settings.

Reducing Non-monotonicities in Combat Models

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Non-monotonic behavior in combat models is an important topic to those using the output of such models as a basis for decision-making. These decisions can be complicated by non-monotonic behavior in the combat models. This research examines the Dewar model, which exhibits non-monotonic behavior caused by the chaos inherent in its structure. The dozen or so previous papers on this model have examined only small subsets of this 18 dimensional combat model. The combinatorial possibilities of main effects and interactions among the 18 dimensions are too great to examine en masse. Consequently, we use some advanced statistics to explore the model with three primary goals. First, systematically explore the Dewar model for additional non-monotonic behavior. Second, determine the effect of stochastic modeling on the non-monotonic behavior of the Dewar model response surface. Third, develop a method for measuring non-monotonicity in the response surface generated by the model.

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Approved abstract unavailable at printing.

Verification, Validation, and Accreditation of MUVES/S2 for U.S. Army System Evaluations of Ground Combat and Munitions System

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For DoD and service decision makers, technically astute and fiscally sound testing is critical to accurately quantify the survivability and lethality of U.S. ground combat and munitions systems in analysis models and wargames. At the weapon system level, deliberate Army experimentation has been used to fill critical data voids and to develop new model algorithms. These efforts have proven instrumental to incrementally extending the applicability of the tri-service AJEM/ MUVES-S2 analysis code for ballistic survivability/vulnerability/lethality analyses of U.S. Army and foreign weapon systems. These rigorous criteria are providing a critical foundation for analyzing new and emerging weapon system technologies. Algorithm and code advances are also supporting Analyses of Alternatives, U.S.C. Title 10 Live Fire Testing, and DoD 5000.2. In February 2001, the Army Test and Evaluation Command (ATEC) accredited MUVES/S2 for use in system effectiveness evaluations to support the Bradley M2A3 program and for use in shot-line analyses, live-fire pre-shot predictions, and generating full-view system-level metrics for combat systems and munitions. In December 2001, the U.S. Army Research Laboratory presented another compelling MUVES/S2 validation package to ATEC for the BAT program. These efforts will be leveraged to support other munitions in Army development such as GMLRS and P3I BAT. This paper succinctly describes the analytical approach, testing methods, analysis techniques, and modeling advances that are being applied to support the evaluation of ground combat and munitions systems for current and future frontiers.

Social Science Methods WG-32

Chair: Dr. John Warner, U.S. Army Research Lab (USARL)
Co-chairs: Dr. Jock Grynovicki, USARL
Dr. Thomas Cook, USARL
Dr. Daniella Markheim, Joint Warfare Analysis Center (JWAC)
Lucia Salvi, USARL
Advisor: Richard Steinberg, Schaeffer Corp.
GIF 358B

The following abstracts are listed in alphabetical order by principal author.

Development of a Human Performance Modeling Environment to Support Conceptual Organization Evaluation

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The US Army Research Laboratory (ARL), established a framework (Barnette and Swoboda, MORS, 2001) for evaluating a series of experiments investigating variations of a concept organization consisting of a Fires and Effects Coordination Cell (FECC) and a Field Artillery Tactical Operations Center (FA TOC). This organizational concept was developed by the Depth and Simultaneous Attack Battlelab to move towards effects-based fires decisions, centralizing fires resources, and affording opportunities to better accomplish the commander's intent. ARL and Micro Analysis and Design (MAAD), Boulder CO, designed a human performance model of the FECC and a FA TOC to conduct 'what-if' analyses for alternative organizational designs, with individuals performing different tasks and functions, using a prototype command and control (C2) system. Desiring greater flexibility and novice usability through the graphical users' interface (GUI) of the FECC model lead to the design of a modeling environment from which one can develop multiple concept models for any number and size of organizations, staffed by any number of people, performing any number of tasks selected from a database of known and concept command and control tasks and functions. This environment is called C2TRACE (Command and Control: Techniques for the Reliable Assessment of Concept Execution) and supports the framework of multiple level simulation validation of C2 concepts. This environment allows the level of analysis to richly grow through an iterative model-test-model framework.

High Rollers: Modeling Autocrats' Risk Acceptance in Unstable Regimes

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A central feature of U.S. strategy in the War on Terrorism has been our reliance on deterring or coercing state sponsors of terrorism: by threatening force we seek to coerce otherwise unwilling states (such as Yemen, Somalia, or Sudan) to crack down on terrorists within their borders without an actual U.S. attack. Success in such coercive campaigns depends heavily on the targets' risk acceptance. The more risk averse the leader, the more likely the state is to comply with our demands without actual U.S. intervention. The more risk acceptant, on the other hand, the more likely the state will be to test U.S. resolve by withholding full compliance. The viability of U.S. strategy – as well as the tactics needed to implement it – thus rest on our assessment of risk preferences in the target regimes. This paper thus presents a model of risk preference as a function of leadership selection effects in unstable political systems, tests this model empirically, and argues from the results that the more unstable the regime, the more likely its leadership will be risk acceptant "high rollers" requiring extraordinary leverage to coerce. The paper then derives implications from these findings for U.S. strategy in the war's coming phases.

Human Behavior Representation in an Agent Based Model Human Behavior

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We present an approach for representing human behavior and personality using Socrates, an agent-based model in Project Albert. Project Albert is a research and development effort of the Marine Corps Combat Development Command (MCCDC) to assess the general applicability of the study of complex adaptive systems (CAS) to warfare, and to provide new methodologies for investigating the results of running such models, and incorporating those results with other, more traditional, methods of analysis.

We capture agent personality via the 'Big 5' Personality Measures: (1) Introversion/Extroversion (I/E), (2) Agreeableness, (3) Conscientiousness (Task Orientation), (4) Emotional Stability, and (5) Intellect/Openness to Experience. We examine agent behaviors and personalities modeled in Socrates and address the relationships among Red, Blue, and other agents.

Development of a Human Performance Modeling Environment to Support Conceptual Organization Evaluation

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As research analysts in today's military, we are often tasked with the set up and evaluation of disparate and dispersed systems (sensors, shooters, and decision makers) that are neither easily quantifiable nor readily accessible. A primary means of capturing user/unit feedback and input data is via a survey instrument. It is recognized that design and administering methodology impacts validity, however current OPTEMPO, personal turnover, and normal unit turbulence also adds to the difficulties facing analysts in their quest for obtaining usefully information in the evaluation of various systems. The task of collecting representative and accurate data is challenging. Often we are not afforded the luxury of positive control when both administrating and collecting surveys. As a result, the information collected may or may not be of any use to the researcher. This issue is of concern due to the amount of time and energy spent both on the researchers and units' behalf. This calls for a careful review of our present methodology to gather information, and whether new approaches in the data collection process are needed. This paper addresses the problems that may exist with our present sampling methodology. The problems associated with sampling are addressed through the use of a basic computer generated simulation based on actual survey results. Several courses of action are suggested to confirm whether the problem exists or not. In the event that there is a problem, several solutions are proposed.

Calculating CATF's "Bacon Number": Command, Control and Social Network Analysis

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Most numerical analyses of Command and Control issues have focused on the performance of information technology networks, communication message flow and individual cognitive performance. New research on human networks, social dynamics and organizational structure, however, is beginning to add rigor, formalism and numerical techniques to the analysis of organizational issues in Command and Control structures. Some of the numerical techniques developed by this research include calculation of coordination and cohesion statistics, calculation of COA possibilities and calculation of conflict percentage in collective decision making structures. This presentation reviews how these techniques were employed in a recent analysis of naval command structures for amphibious operations

Counter-deception and Sense Making During Urban Operations

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The current world situation begs us to examine requirements unique to urban military operations, including counter-terrorism and homeland defense. The United States and its allies must assume that adversaries will play to its weaknesses, which may include capability to detect, make sense of, and counter deceptive operations. The focus of this presentation is a framework for information and knowledge to facilitate sense making and to counter a sophisticated capability for deception during military operations in urban operations. Specific operational issues will be discussed in the context of the sense making paradigm to better understand the many complex factors (e.g., military, civilian, political, social, and physical/environmental) that interact to influence military decisions. During urban operations, U.S. Forces are susceptible to deception, particularly information deception. The quality of military sense making and decision-making in urban environments depends, in part, upon accurate assessments of others' interests, intentions, and capabilities, as well as accurate assessments of the environment or context within which the action takes place. Forming accurate perceptions is a challenge even during favorable circumstances in which clear and unambiguous communication between parties or extensive preparation and rehearsal for a particular turn of events can occur. In complex urban settings, we must be prepared for unfavorable circumstances, which might include occasions when events are unfolding at a very fast pace or when the background noise of contradictory opinions interferes with the accurate gauging of the intentions of others. Included within these unfavorable circumstances is a subset in which one or more participants attempt to deceive the other. Clearly, one of these requirements is the ability to make sense of the intentions, capabilities, and tactics of adversaries. The presentation suggests various "testable" hypotheses to investigate the dynamics of counter-deception in urban operations.

Interactive Hypothesis Generator to Support Counter-deception in Information Operations (IO) via Formal Concept Analysis (FCA) using Incomplete Data.

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A major risk to the success of military operations in the 21st century is the failure to recognize and counter a deception. In information operations (IO), we anticipate a highly sophisticated and creative class of equally active and creative. Automated countermeasures based on doctrine and history are likely to be of limited use. Only human domain experts will be able to apply informed intuition to "smelling the rat" of deception and uncovering true intent. However, while humans are good generating relevant hypotheses, they are less good at discriminating the critical facts needed to test them. Formal Concept Analysis (FCA), a tool for inducing lattices of concepts and relations from data, augments the expert by providing logical clarity to human understanding of relational data in a visually compelling format. We propose a family of interactive information fusion tools based on FCA for IO counter-deception.

The Impact of Maintenance Modeling for the Joint Biological Point Detection System

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Although the Improved Performance Research Integration Tool (IMPRINT) has been widely used for its operational task network analysis capability, it was also designed to facilitate maintenance requirements analysis. IMPRINT models maintainer manpower requirements at the system, unit, and force levels. The maintenance capability in IMPRINT was used to model the Joint Biological Point Detection System (JBPDS), a system designed to detect biological agents in a host of environments. Due to the recent threats against the U.S., this system has received increased attention and the need for expeditious analysis of the maintenance requirements was critical to timely development and deployment. Through this modeling effort, we determined that by optimizing maintenance at the organizational level, significant savings in time and

manpower costs were realized. IMPRINT maintenance modeling provided insight to the overall JBPDS maintenance issues and these early insights will facilitate maintenance predictions for product improvements to the JBPDS in the future.

Execution Plan Selection and Validation for Ground-Based Midcourse Missile Defense Command & Control

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Recent reviews, exercises and simulations conducted with the developing Ground-based Midcourse Defense (GMD) Battle Management, Command, Control, and Communications (BMC3) system indicate that some significant usability concerns exist. Several reports identify the need for more information about how the system *is* behaving or *would* behave under certain circumstances. Operators characterize this need as a lack of support for decision-making and task execution tools within the interface (e.g., Holz, 2000; Allan, 2000), as well as a need for improved situation awareness as an essential component of Human-in-Control functionality (TRW, 2001). The current Build Increment 2 (BI-2) interface provides users with a number of controls allowing them to directly influence both how the system fights the battle, and the predicted outcome of the battle. However, operators are provided little, if any, capability to appreciate what the outcome of such actions will be before the actions are implemented.

To address these issues, two new Battle Management, Command & Control (BMC2) displays were developed using an Object Oriented Task Analytic approach (Steinberg, 2000). The new displays featured integrated decision-making and control capabilities intended to improve operator task efficiency and situation awareness. These two new displays were compared with the existing (BI-2 baseline) interface in two experiments to identify potential performance differences when performing representative operator tasks. The first experiment assessed operator ability to perform complex data extraction tasks using the three display formats, while the second focused on operator interaction with the displays while following a set of tactically relevant rules. Results of both experiments showed significant benefits of the new displays in terms of response time, with both new displays outperforming the baseline interface. In terms of accuracy, however, the baseline interface was the best overall performer. Results also indicated which displays were superior for supporting particular tasks, and identified display characteristics that improved operational performance in the BMC2 environment.

Development of Shared Situation Awareness Methods for Collaborative Command and Control Environments

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The current method for developing the Human Computer Interface for complex military systems fails to take into account multiple operators who will interact with that system. Traditionally, two approaches are taken in development of screens - first, to give all operators access to all screens thereby putting the burden on the operators to define roles; second, to physically segregate screens based on pre-defined roles thereby removing any flexibility in adapting those roles for changing environments.

Emerging concepts in facilitating group interaction or "team spaces" provide promise in maintaining team awareness of each operator in three important ways - first, to help commanders confirm that their team is accessing appropriate windows and performing appropriate functions; second, to enhance the interpersonal trust between operators that the system is being controlled properly and decreasing concerns about "who is doing what, when, and why"; finally, to enhance man/machine trust by increasing situation awareness of the processes being executed by not only the operators, but the system itself.

A Knowledge-Based System Evaluation Methodology for the Army's Battle Command System.

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One of the U.S. Army Research Laboratory's (ARL's) Science and Technology Objective (STO) research projects is to develop a methodology and metrics to quantify integrated soldier and staff digital information system performance on the digital battlefield. The assessment of the human performance with digitalization is one of the most complex and challenging tasks that U.S. Army leadership must accomplish to assure a commensurable return on its digitization investment. Military organizations and their operations involve multitudinous human interactions using military personnel at various levels of expertise. Emerging digitized command and control (C2) systems have the potential to help the military accomplish their missions but do not eliminate or lessen the human factor.

Thus, a framework for assessing digital staff performance was established that considers, hardware, battle command functions, soldier operator capabilities as well as staff and leader dynamics. This Human Dimension of Battle Command initiative is intended to help the Joint and Army leadership assess the impact of digitization on individual soldier, staff and performance. The assessment will be accomplished by studying iterative Army Tactical Command and Control Systems (ATCCS), soldier-system interface designs, and the Global Command & Control System-Army (GCCS-A) as they support command decision-making processes, related battlefield operating systems (BOS) C2, and information management operations. The lack of emphasis on the human component in the design and integration of automation can result in significant performance degradation, increased training requirements, and a lack of system acceptance by the soldier.

Characterizing the Terrorist Threat

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In transitioning from the Cold War to the post-Cold War security context, several metaphors have been forwarded to help characterize today's terrorist threats. This paper presents and develops three such metaphors: terrorism as (1) a corporation, (2) a computer network, and (3) warfare by other means. Common themes and lessons are drawn from these metaphors, most notably that terrorist networks are more diffuse than previous, Cold War era adversaries and that terrorists have the potential to attack more and different types of targets, though less lethally. In conclusion, it is suggested that simulation can be used to characterize terrorist threats, the economic systems that support them, and the military and economics systems that terrorists might target.

Evaluating Psychological Effects of Anti-Personnel Landmines Using Unexploded Ordnance

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The long-term destructive effects of anti-personnel landmines (APL) on civilians have resulted in international support for limiting the use of APLs. In 1997 President Clinton announced that APL alternatives be developed to end use of APLs by 2003.

Evaluation of APL alternatives requires an understanding of the psychological effects of landmines. The Army Research Laboratory has developed a methodology that evaluates physiological and psychological stress and its relation to changes in task performance. A Comprehensive Stress Assessment Battery uses standardized psychological trait and state questionnaires to measure perceptions of stress. A Salivary Amylase Field Kit uses a saliva sample to provide a physiological assessment of stress. Amylase concentrations are predictive of plasma catecholamine levels.

Kolasinski (1999) collected data from individuals with APL experience in non-training settings. Similarities were reported between the psychological effects of APLs and unexploded ordnance (UXO). This research proposes to assess the psychological effect of UXO as a comparable measure of the psychological effect of APLs. Data were collected on the Hawaiian Island of Kaho'olawe where long term UXO clearance operations are currently being conducted. The Kaho'olawe UXO clearance project is a joint effort between the Navy and the state of Hawaii, with the objective of returning the island to a condition safe for human use.

Participants were civilian employees working on the UXO clearance project. Pre, during, and post measures were collected for four days. Baseline and trait measures were collected on a non–workday. Overall stress perception data and physiological data indicate that UXO clearance workers did not experience high levels of stress. This is likely due to experience, training, and safety procedures in effect at the work place. Highly trained explosive ordnance disposal (EOD) teams likely experience lower levels of stress than the typical soldier exposed to APLs. UXO clearance personnel do not experience the time constraints and pressures of the surrounding battle that a soldier encounters when clearing a minefield.

Exploration of IO-specific CoGs

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Traditional Centers of Gravity (CoG) decompositions, such as Warden's theory, attempt to capture an adversary's sources of power and control. While they continue to hold validity in today's military operations, their value appears to apply most directly to the traditional kinetic type of war planning for nation states. Albeit attempts to transition existing approaches to an Information Operations (IO) oriented arena have advanced adversarial modeling research, some issues remain to be addressed. I surmise that a part of the present problem is the fact that previous CoG concepts fail to seamlessly translate from kinetic to information warfare. As a result, any attempts to simply apply a traditional CoG mold would only capture some of the dynamics necessary for effective IO war planning. For instance, current CoG theories could be supplemented with increased sensitivity to ethnocentric viewpoints. What we may view as the most beneficial or opportune route, may be quite different from that of an adversary with a diverging frame of reference mediated by culturally-based variables. Additionally, models fail to account for an individual's leadership preferences by focusing on centers of power and control such as industry and military. As a supplement to existing CoG planning/development theories, I am proposing a set of CoGs that would allow greater insight into other sources of power that cover a broader spectrum of variables believed to be important to Information Operations.

Determining the Homeland Security Force Structure Requirement

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Beginning in the spring of 2000, the Army undertook efforts to change the paradigm of treating Homeland Security as a lesser-included force structure requirement. The results of this shift led to the development of the Army Strategic Planning Guidance (coordinating draft, September 10, 2001). This planning guidance serves as the framework for determining the Army's force requirement to support Homeland Security. There are seven basic mission types that are covered in the planning guidance. The study employs three techniques to determine the requisite force structure for each mission type. The first technique involved collecting known information of current force structure that had a Homeland Security role. The second used a forecasting tool, Stochastic Analysis of Resources for Deployments and Excursions (SARDE) that uses historical events to predict the average monthly force requirement for certain mission types. The final technique involved basic set theory to estimate the requirement based on several possible scenarios. The results of this study were used in the Total Army Analysis '09 process that determines the desired total active and reserve component requirements through year 2009. These results also give a defensible force structure that Army planners can use to convey its requirements to the Joint Staff and sister services. Lastly, the study demonstrates how the Army is currently supporting the National Command Authority's efforts to ensure the safety and security of the nation.

Analytical Techniques for the Development of Requirements Analysis Using Situation Awareness as a Measure of Effectiveness

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It often appears that the primary design driver for information technology (IT) systems is expedience rather than human strengths and weaknesses. Many systems have been designed to provide the solider with the information that can easily be

obtained rather than by first determining the type of information that is most needed. Most IT systems provide all the information in one modality. Very few systems provide processed information so that higher-level situation awareness can be easily attained. In support of the Smart Sensor Web program, ARL developed an approach to the design of IT systems that includes: the determination and documentation of critical information requirements (CIRs); the determination of the preferred modality of display for each CIR; and the evaluation of sensor mixes and density needed to obtain the CIRs. This approach uses the situation awareness center methodology developed by ARL to quantify the contribution of IT variables to the SA of soldiers at the squad member, fire team leader, squad leader, and platoon leader echelons

Comparison of Social Network Analysis Techniques

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Social networks depict the complex relationships of individuals and groups in multiple overlapping contexts. Influence in a social network impacts behavior and decision making in every setting in which individuals participate. This paper defines a methodology for modeling and analyzing this complex behavior using a Flow Model representation. The results using Flow Modeling are compared to existing Social Science methods both theoretically and for representative cases of interest. Primarily, the flow modeling approach is compared to Multi-Dimensional Scaling with respect to modeling and analyzing social network phenomenology. This paper is a result of a three year research effort sponsored by the National Security Agency and National Air Intelligence Center.

Human Science Data to Support Modeling and Analysis of Objective Force

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The face of the battlefield has changed dramatically in the past decade, and our models and simulations must be enhanced to reflect these changes. In order to develop the modeling and simulation tools needed to assess new and evolving technologies for the individual combatant of the Objective Force, it is important to develop an understanding of the complexities and interactions that are involved during the many different types of future operations. Collecting meaningful behavioral data from these types of missions, to include the military operations in urban terrain (MOUT) environment, presents a unique set of challenges to today's researchers. To date, there is little human performance data in close combat environments or MOUT and thus the Human Science Modeling and Analysis Data Team was formed to design and conduct two studies to begin this effort. Both studies were conducted at Ft. Benning, GA and focused on target engagement and troop movement performance data. The first study was conducted in a virtual environment at the Dismounted Battlespace Battle Lab's (DBBL's) Simulation Center while the second study was conducted in the field at the DBBL's McKenna MOUT Site. These studies served several purposes: to assess the viability of these facilities as data collection sites, to examine and implement various data collection methodologies, to determine whether the two data sets from virtual and field environments are correlated, and to use the data in the development and validation of constructive computer models for the dismounted combatant. This paper describes the design of these experiments and presents initial findings and trends.

Determining Skills Required for Future Duties

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Future conflicts will require a strategically deployable and sustainable force that will provide a quick reaction capability for missions that will arise in this century. The Future Combat System (FCS) is envisioned to be a mixture of manned and unmanned combat systems that will exploit information dominance to develop a common, relevant operating picture and achieve battlespace situational understanding. The FCS will have to be relatively light (20 tons) and small in order to be deployed quickly and efficiently. The FCS's success in combat will depend on seeing and killing the enemy at a distance utilizing robotic platforms in the air and on the ground. Personnel controlling these robotic platforms will utilize hardware

and software (operator control units-OCUs) in order to maneuver the robotic platforms; detect, classify, recognize, identify and engage the enemy; report battle damage; and maintain situational awareness.

The Army needs to know what skills are required to perform OCU tasks for purposes of human factors design, training, and selection. One skill taxonomy that has been useful in classifying human performance skills is that of Fleishman and Quaintance (1984). This taxonomy organizes 50 individual skills into two overall classifications (cognitive and experience clusters; and perceptual-motor ability clusters) each containing four skill clusters.

We collected data during an experiment to examine requirements for the FCS An objective of the experiment was to determine the skills and abilities required of OCU users. The user task examined was "Maintain Situational Awareness (SA)" Results of within-subjects (i.e., repeated measures) paired comparisons of the JASS skill clusters for the task "Maintain SA" showed that the highest rated skill clusters for "Maintain SA" are "Conceptual", "Communication", "Speed Loaded", and "Vision." The cluster "Conceptual" involves such skills as flexibility of closure (the ability to detect a known pattern), visualization (the ability to predict how a pattern will appear after changes are carried out), problem sensitivity (the ability to tell when something is wrong, or likely to go wrong), and spatial orientation (the ability to tell where you are in relation to the location of some object, or vice versa). Communication involves written and oral expression and comprehension. The cluster "Speed Loaded" involves such skills as speed of closure (combining different pieces of information into a meaningful pattern quickly), perceptual speed and accuracy (comparing patterns quickly), and time-sharing (shifting back and forth between sources of information, such as different screens or human versus computer input). Visual skills involve near vision, color discrimination and glare sensitivity.

The presentation will discuss the highest ranking individual skills within each cluster, and human factors design, training, and selection necessary to ensure that FCS OCU operators are able perform these skills.

Warfighting Experimentation WG-P1

Chair: Lauran Winter, JFCOM J9/TRAC
Co-chairs: Dr. Russ Richards, MITRE, USJFCOM J9
Ms. Myra Baugh, USJFCOM J9
Col Steve Pennington, Air Force Battle Lab Integration Office
Mr. James Liepman, Zell Tech, AC2ISR/AFEO, USAF
Mr Jim Calpin, MITRE Corp
Ms. Lynn Leath, TRADOC Analysis Center, US Army
Bob Eberth, MCWL, USMC
Advisor: Mr. Gabe Rouquie, Northrop Grumman
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The following abstracts are listed in alphabetical order by principal author.

Measures of IO Effects

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The Joint Staff Analysis Model (JSAM) was developed for the US Army Battle Command Battle Lab to analyze command post performance. JSAM has been selected as the Army's J/AWE tool to support Millennium Challenge 02. One application of JSAM is to develop some measures of the effects of selected information operations on Blue or Red organizations. Since JSAM already models the performance of an organization without IO, including IO effects will provide quantitative measures of IO on organizational performance. Measures include times to complete tasks, resource utilization over time, quality of information products, effects on coordination, and other measures already represented in JSAM. Note that these are not all of the measures possible for IO, nor do they represent measures of all types of IO. However, this set of measures is a useful starting point for developing more objective measures of a wide range of offensive and defensive IO. We present a proposed approach for incorporating a JSAM-based IO analysis as part of a limited objective experiment for Millennium Challenge 02.

Sustaining Continuous Joint Concept Development and Experimentation Strategy

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Joint Forces Command, Joint Futures Lab is a relatively young organization. One of the challenges faced by the organization is establishing a battle rhythm that synchronizes DoD's Transformation effort with the Service Components and CINCs.

This presentation will submit the latest battle rhythm, as well as modified naming conventions, developed for sustaining continuous Joint Concept Development and Experimentation. A single pathway of concept development and experimentation will be described as well as the synchronization of concept development and experimentation pathways that repeats a 24 month cycle. This process provides the necessary analytical rigor as well as agility and flexibility to JCD&E.

Multinational Collaboration and Information Sharing Limited Objective Experiments

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This paper describes a series of Multinational Collaboration and Information Sharing Limited Objective Experiments (LOEs) that examine multinational aspects of joint command and control concepts at the US Joint Forces Command

(USJFCOM). The experimental goal is to better understand how multinational partners should share information and do collaborative planning and execution in the future. The Multinational LOEs also aid in defining multinational participation in Olympic Challenge 2004 (OC04), a major USJFCOM experiment that will examine Rapid Decisive Operations (RDO) in the 2010-2020 timeframe. USJFCOM Joint Futures Lab conceived RDO as a way to deal with future adversaries in an expeditious manner. Since it is unlikely that the U.S. forces would act unilaterally against an adversary, it is important that the RDO concept include provisions for coalition partners.

LOEs are designed to be both discovery events and structured experiments. Since LOEs are pilot efforts for larger more complex events that follow, there is an element of discovery that is extremely useful. It is far better to discover flaws in a small venue when corrections are easier rather than a large public event where correction is difficult. The Multinational LOEs are also structured to examine assertions made by joint concepts. Measures and associated data collection quantify the degree to which collaboration and information sharing take place under different conditions.

The first Multinational LOE was completed in November 2001 and focused on collaborative planning with Multinational partners who are planning RDO when the planning time is short. The experiment compared COAs developed using a traditional process with a plan using an integrated planning process. The traditional planning process was adapted from the Multinational Interoperability Council (MIC) Lead Nation Concept, and the integrated planning process was based on the Joint Command & Control Capability (JCCC) and the Standing Joint Command & Control Element (SJC2E). Both support development of an RDO ONA.

The Multinational LOE was also an opportunity to collect valuable information on distributed collaborative planning. Data were collected through observers, surveys, and questionnaires, which were used to characterize the two methods used to develop COAs. Data collection was a mutual effort of research centers, laboratories, and organizations from the participating nations.

Millennium Challenge 2002 Model-Experiment-Model Methodology

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United States Joint Forces Command will use a Model-Experiment-Model (M-E-M) paradigm to overcome some of the limitations of conducting a large, single-trial field experiment and to establish the foundation of a continuous experimentation environment. Since MC02 does not have an "on-the-ground" baseline to determine effectiveness gains, the focus in M-E-M is to build a constructive baseline for comparison to a constructive Rapid Decisive Operations Joint Task Force variation that has been calibrated to the results of the field experiment. The use of M-E-M in Millennium Challenge 2002 (MC02) will be as a "proof-of-principle" intended to determine its potential and the process with which to integrate it into joint experimentation.

Rapid Initialization of Course of Action (COA) Tools Using Data from GCCS

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Over the past several years, simulations have been increasingly used as a way of developing and evaluating courses of action (COAs) during staff-level training exercises. However, one of the major drawbacks in using such tools in the inability to rapidly populate such simulations with data that exists in C4ISR systems. In the majority of instances, unit data is read directly off of the available C4ISR system and input manually into the COA simulation. This process can be time consuming and is prone to errors - due to both the manual nature of the process and the fact that the tactical picture may change significantly by the time all the data has been input.

During the Navy's Global '01 Wargame last year, an automated process for initializing the Naval Simulation System (NSS) based directly on available track data in the Global Command and Control System (GCCS) was used for the first time in an exercise. The interface leverages standard M&S and C4I architectures - employing components based on the DII COE and the High Level Architecture (HLA). Use of this capability led to a significant improvement in the speed in which NSS

could be initialized, and also the accuracy of the COAs evaluated. Because it was used directly by the NAVFOR cell in the exercise, it helped to streamline the C2 decision process for the training audience. The success of this application has led the Navy to employ it on the USS Coronado during the upcoming Fleet Battle Experiment - Juliet (FBE-J), during the summer of 2002.

This year the GCCS-NSS interface was extended to include a second COA application - the Integrated Theater Engagement Model (ITEM). The GCCS-ITEM initialization capability will be used during exercise Reception, Staging, and Onward Integration (RSOI) in Korea in the Spring of 2002, and again during exercise Ulchi Focus Lens (UFL) in Korea later in 2002.

This presentation will cover lessons learned in all of the exercise and experimental uses outlined above and discuss future plans for both applications. It will also discuss potential future areas involving the interoperability of C4ISR and M&S systems that could significantly improve the C2 decision process.

Wargaming to Support Objective Force Concept Development

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The Objective Force is the realization of the Army vision that was presented by the Chief of Staff of the Army (CSA) in October 1999. The transformation from vision to fielded Objective Force is a process that will occur over several decades. An early and critically important piece of this process is the development of Operational and Organizational (O&O) Concepts. These Objective Force O&O concepts are grounded in the futures work that was done as part of the Army After Next (AAN) project. Futures wargaming has evolved to become an important part in the development of these concepts. In particular, the annual Army Transformation Wargame (ATWG) has emerged as the Army's most visible event for future concept development.

The TRADOC Analysis Center (TRAC) serves as the lead analytic agency for the ATWG sponsored by the TRADOC Deputy Chief of Staff for Doctrine (DCSDOC). This series of wargames is designed to describe, refine and evaluate Objective Force concepts and capabilities over a multi-year period. These wargames provide the Army an opportunity to explore future Army operations at the strategic and operational levels of war in a political/military wargame environment.

This presentation will address the analytic support provided to ATWG 01, *Vigilant Warriors*. In particular, it will provide an overview of the wargame to include analysis and reporting of the insights for the issues addressed.

Collaboration and Knowledge Management in an Experimental Effects-Based Operations Environment

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Effects-based Operations (EBO) is defined as a "process for obtaining a desired strategic outcome, or 'effect' on the enemy, through the synergistic and cumulative application of the full range of military and nonmilitary capabilities at all levels of conflict." [p. ii, 1] An effect is the physical, functional, or psychological outcome, event, or consequence that results from specific military or non-military actions. The EBO concept is based on the tenant that a better understanding of the adversary and the increased involvement of other national agencies will lead to better-reasoned options to engage potential adversaries.

Key aspects of EBO are the ability of decisionmakers to quickly recognize any unexpected effects and the flexibility and agility to adapt to the implications of those effects. This highly adaptive quality is anticipated to increase prospects for success while reducing the potential for failure. A second key aspect of EBO is an emphasis on the ability to

examine the causal linkages and effects through which actions lead to objectives. Causal linkages help planners understand why a proposed action could be expected to produce a desired effect given the current circumstances. A third aspect is the broadened focus of the Joint Task Force (JTF) Commander to producing effects against an adversary's will and behavior in addition to his means and capabilities. This ability to more precisely select the right set of actions offers the Joint Force Commander the ability to further minimize undesired collateral effects.

An experiment entitled Effects Tasking Order-to-Actions Limited Objective Experiment (ETO-to-Actions LOE), was conducted at the US Joint Forces Command (JFCOM), Joint Experimentation Center, Suffolk, VA, 3-14 December, 2001, to examine aspects of EBO, and to specifically assess and refine the effects-based planning and assessment (EBPA) processes. This experiment was designed and conducted by a partnership of the Naval Postgraduate School, JFCOM J9, and the Navy Warfare Development Command. Previous experiments and events focused primarily on the Joint Force Headquarters (JFHQ) level of command, with the majority of effort directed at refining the process down to producing an ETO (which effectively issues effects-based orders to the subordinate functional components). The ETO-to-Actions LOE focused within and below the JFHQ to examine the required coordination and collaboration processes (both vertically and horizontally) between the JF and functional components headquarters, which is needed to collaboratively develop the ETO and translate the effects directed in it into tactical actions on the battlefield.

The experimental participants included representatives from all services, organized into a Joint Task Force HQ staff and functional component HQ staffs (air, maritime, land, special operations force, and political). Thirty-nine percent were active duty and forty-two percent were retired military personnel. Three days of training on the new processes and collaboration tools were provided to familiarize participants with the new concepts. Five days of game execution consisted of the collaborative planning between the Joint Task Force staff and the subordinate functional component staffs, culminating in the JTFC issuing an ETO to the Joint Force.

Three surveys were administered during the experiment to gather data on the effectiveness of (1) the collaborative tools and the training provided to the participants for this experiment, (2) knowledge management and collaboration as critical aspects of EBO planning, and (3) the EBO planning and assessment process. This paper reports on the results of the Knowledge Management and Collaboration Survey, and is a companion paper to two other papers that report on results of the other two surveys. Twenty-nine items comprised the KM survey. Participants were asked to rate the extent to which they agreed with statements by using a five-point Lickert scale that ranged from "strongly disagree" to "strongly agree." The survey was administered to the 99 experimental participants; 95 completed surveys were returned.

Survey items related to situation assessment and information management asked participants about their level of situation awareness within their cell and across the JTF/Component organization, their ability to obtain adequate and timely information, types of information they were unable to obtain and causes of problems in obtaining information. Other survey items pertained to the effectiveness of the organization the effectiveness of asynchronous collaboration sessions; and the extent to which they were able to conduct collaborative planning that was closely coordinated with subordinate commands. In addition, survey items measured the effectiveness of the ONA, ability to assess the value of engaging a specific adversary node, and the presentation aspects of information.

1 *A Concept Framework for Effects-Based Operations*, White Paper Version 1.0, 18 October 2001. US Joint Force Command, J9, Concepts Department, Suffolk, VA.
2 *Operational Net Assessment*, TTP for MC02, Draft Version 1.2, 20 November 2001. US Joint Force Command, J9, Concepts Department, Suffolk, VA.

Decision making in an Information-Rich Command and Control Environment

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An overarching theme driving the development of future joint military organizations is the need for Rapid Decisive Operations (RDO). Rapid decisive operations are characterized by immediate, high-tempo, continuous overwhelming operations, and the ability to shape and control the battlespace, integrate application of precision effects and dominant maneuver, and minimize the need for protracted campaigns. To facilitate RDO, a number of emergent concepts are being investigated at US Joint Forces Command (USJFCOM), Suffolk, VA, including: the Experimental Joint Force Headquarters, Joint Interactive Planning, and a Common Relevant Operational Picture. These concepts reflect the need for unprecedented human and technological synergy in organizational structure, process, collaboration and display media, and adaptation to dynamic circumstances. Of particular importance is the nature and method of information exchange that RDO will require in a network-centric environment.

The objective of Global 2001 was to explore NCO by conducting Joint/Coalition contingency operations with uncertain warning using rapidly deployable forces. Two specific concepts were used as implementing vehicles: Rapid Decisive Operations (RDO) and the Joint Mission Force. These vehicles were intended to support investigation of several focus areas,

one of which is the focus for this paper: Decisionmaking in an Information Rich Command and Control Environment. This paper will present results of analysis of data collected to help refine emerging concepts being defined at USJFCOM related to C2 in an information-rich environment.

A survey was administered to obtain data on organizational effectiveness, information flow and knowledge management, collaboration, situation awareness, and the use of advanced information technology tools. In addition, a team of observers, stationed throughout the organization recorded key observations related to operational performance and the emerging concepts being investigated at USJFCOM. The objective was to glean insights that can help expand and refine the emerging concepts being developed to transition to Joint Vision 2020. Results of analysis of data gathered from 59 participants who completed the survey will be discussed.

An Integrated Gaming System for the Army Transformation Wargame

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The Integrated Gaming System (IGS) is an integrated, model-supported gaming system consisting of a set of tools linked to a common database and capable of supporting a wide range of gaming requirements. The U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC) provides contract oversight management for the development and use of the IGS in support of the TRADOC Deputy Chief of Staff for Doctrine (DCSDOC). The Wargaming and Futures Directorates within DCSDOC are the program and systems' sponsors.

The IGS is a Booz-Allen & Hamilton (BAH)-developed wargame automation system that fulfills the functional requirements of the Wargame Architecture (WGA) concept, which developed out of requirements identified by DCSDOC beginning in 1996. DCSDOC identified these requirements while preparing for a series of wargaming events that supported the Army After Next (AAN) future studies effort. The purpose of the IGS is to perform the functions of the WGA in support of TRADOC's Army Transformation wargame, study, and research efforts. This presentation provides an overview of the IGS system, its components, and its use during last year's Army Transformation Wargame - *Vigilant Warriors 01*.

Effects-Based Planning and Assessment: Examining and Refining the Process

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The United States Joint Forces Command (USJFCOM) J9 is leading a transition toward a new approach to warfare. A cornerstone of this new approach is the concept of Rapid Decisive Operations (RDO), which integrate knowledge, command and control, and Effects-based Operations (EBO) to achieve the desired strategic outcome or "effect" on the enemy through the synergistic and cumulative application of the full range of military and nonmilitary capabilities at all levels of conflict.[1] In preparing for and conducting a RDO, the military acts in concert with and leverages the other instruments of national power to understand and reduce the adversary's critical capabilities and coherence. Focusing on effects, rather than attrition, enables a highly coordinated level of interservice, interagency, and international cooperation.

The shift to EBO effects both planning and assessment. Traditionally, military planners would focus on consideration of factors such as the number and type of aircraft to be employed, types and quantity of weapons to be used, and the number of sorties to be flown. Now the goal is to emphasize what all these weapons and platforms will accomplish, that is, what overall *outcomes* will be achieved.[3] Similarly, the effects assessment (EA) process goes beyond traditional attrition-related and performance-related assessments included in today's combat assessment process. EA must be a continuous feedback process that can collect, process, exploit, and disseminate information to

the appropriate level (strategic, operational, or tactical) in time spans that allow commanders to make decisions in an intensely dynamic situation. The EA perspective includes "determination of whether some, or all of, the desired effects were produced and, if so, to what level, what unintended effects were produced, their overall impact on the joint effort, and how the tactical actions taken either contributed or failed to contribute to obtaining the desired outcome." [3] The experiment reported on in this paper is part of a sequence of experiments and events planned to test and refine new concepts being developed at USJFCOM J9.

An experiment entitled Effects Tasking Order-to-Actions Limited Objective Experiment (ETO-to-Actions LOE), was conducted at the USJFCOM, Joint Experimentation Center, Suffolk, VA, 3-14 December, 2001, to examine aspects of EBO, and to specifically assess and refine the effects-based planning and assessment (EBPA) processes. This experiment was designed and conducted by a partnership of the Naval Postgraduate School, JFCOM J9, and the Navy Warfare Development Command. The previous experiments and events focused primarily on the Joint Force Headquarters (JFHQ) level of command, with the majority of effort directed at refining the process down to producing an ETO (which effectively issues effects-based orders to the subordinate functional components). The ETO-to-Actions LOE focused within and below the JFHQ to examine the required coordination and collaboration processes (both vertically and horizontally) between the JF and functional components HQs, which is needed to collaboratively develop the ETO and translate the effects directed in it into tactical actions on the battlefield.

This paper will focus on summarizing data obtained from a survey administered at the conclusion of this experiment to obtain feedback on how well the EBPA process worked. Survey items asked respondents to rate their answers, using a 5-point Lickert-type scale that ranged from "strongly disagree" to "strongly agree," on questions that asked about such topics as the following: areas of the effects-based planning and assessment process needing further refinement, what parts of the process are particularly challenging (so that these can be enhanced and more fully trained), what data/ information/assessments need to be provided to better enable the process, how well this process facilitates development of more complete/ robust courses of action, and whether JTF planners were able to develop measures of effectiveness for the desired effects that were meaningful and observable. Additional areas included in the survey include items regarding whether use of the Prioritized Effects List supports JTF-level decision making, whether the right number of people were involved in the planning process, the ease with which participants were able to stay informed when updates and changes were made, the effectiveness of the components participation in the planning process, and several other aspects of the effects-based planning and assessment process.

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Collaborative Tools: An empirical Assessment of Desired features

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Rapid access to current, relevant, and accurate information and the ability to engage in real-time collaboration with other decisionmakers who are geographically distributed have become indispensable elements of the Joint command and control (C2) planning and decisionmaking process. Collaboration tool suites were introduced to facilitate these information-intensive interactions during two recent events. These events were Global Wargame 2001, held at the Naval War College, in Newport, RI, 16-27 July 2001, and an experiment conducted at US Joint Forces Command, Suffolk, VA,

3-14 December 2001. New information technology (IT) tools, used as part of a networked, web-based collaborative system were also introduced. These tools were developed to support operational planning and decisionmaking processes by providing an alternative means to communicate, collaborate, and share information among warfighters that extends what is available in today's current operational environments. A key objective for both events was to obtain empirical data on the effectiveness of these new tools for supporting future operations in a distributed, network-centric joint force and to identify user defined enhancements that would better meet future Joint operations requirements.

The need for extensive collaboration and coordination across functional areas and components within the organization to accomplish the mission was recognized as key to the success of both events. Enabled by high-speed bandwidth connectivity and electronic collaboration tools, a collaborative information environment is anticipated to facilitate the exchange of information among members of the Joint Force and those organizations supporting or being supported by the Joint Force. The Joint Task Force conducted effects-based planning and assessment in a collaborative information environment that provided decisionmakers the ability to share information and produce the recurring and non-recurring products that were required. The long-term goal for operating in a collaborative environment is to reduce planning timelines while increasing organizational effectiveness.

A web-based tool, called the Wargaming Information Grid System (WIGS), and a collaborative planning and operational environment, the Information WorkSpace (IWS), provided the core for both collaboration tool suites. At Global Wargame, where the goal was to use innovative technologies to enhance all aspects of the operational decisionmaking process, the following tools were provided to participants in addition to WIGS and IWS: Battlespace NT, Text Documents, the Knowledge Wall, Email, Text Chat, Voice, and Video Teleconferencing. At US Joint Forces Command, where one goal for the experiment was to develop an understanding of the implications and effects of distributed planning, the following tools were provided to participants in addition to WIGS and IWS: ADOCS, ONA Tool, and JDIM. The automated deep operations coordination system (ADOCS) is a joint service mission management software application that presented the visual display of the battlespace. ADOCS provides a suite of tools and interfaces for horizontal and vertical integration across battlespace functional areas. The operational net assessment (ONA) tool was accessed through WIGS and provided an initial assessment of the military operation from multiple points of view. These other views include information and analysis from other branches of the US Government and many others as well as non-governmental organizations' needs and requirements. The Joint Distributed ISR Management Tool (JDIM) enabled the user to find what intelligence, surveillance, and reconnaissance information existed at particular nodes.

The Information WorkSpace (IWS) is a collaborative planning and operational environment designed to be used within and among the functional and service components. IWS was designed to facilitate collaboration where planning was required to produce the recurring and non-recurring products produced in response to the game play. Capabilities afforded by IWS were expected to be tailored by the users to their specific requirements. Some functions provided by IWS include real-time text chat and voice, both conducted over the internet. Text chat is a tool within IWS, and provides a form of interactive communication where more than one person can join the chat session to collaborate. All occupants within a virtual "room" (within the IWS tool) can view and respond interactively to an initiator's message. Voice is also a tool within the IWS where a person can talk with everyone who is in the same "room."

The War-Gaming Information Grid System (WIGS) was designed to be the central source for shared awareness during scenario play. WIGS was developed to be the authoritative data source for game information. For Global Wargame 2001, an interactive homepage was developed to provide players with a means of planning, communicating, and promulgating orders. Promulgation of this information via the website was intended to facilitate changes to the common operational picture and also provide for review of players' decisions, strategy, and direction both during game play and afterwards.

The objectives for this website were to: (1) provide a location to post information for all players, (2) provide access to analytic tools and to an underlying database of reference and briefing materials, (3) facilitate posting and exchange of documents, as well as (4) provide links to additional websites, hosted within the Wargaming Center, NWC, in order to provide additional information related to game play. Text documents were a collection of documents located within the web-based gaming architecture. These documents included material such as the Battle Plan, Commander's Intent, Rules of Engagement, and many others.

Division Capstone Exercise (DCX) Analysis and Results

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The Division Capstone Exercise (DCX) was a two-phased capstone event (not a test, experiment, certification, or pass/fail event) to demonstrate the warfighting capabilities of the Army's first digitized division -- the 4th Infantry Division (Mechanized) (4ID). The Army conducted DCX Phase I (DCX I), which engaged fully digitized forces for the first time in a

combat environment, at the National Training Center (NTC) in Ft. Irwin, CA 1-14 April 2001. DCX Phase II (DCX II), a BCTP warfighter exercise, was conducted 6-10 October 2001 at Ft. Hood, TX and surrounding areas.

DCX represents an important milestone in the Army's transformation. Beginning in 1994 under the spiral development process, the Army launched a series of AWEs involving 4ID, culminating with the DAWE in 1997, to incorporate and evaluate a range of improvements in organization, doctrine, combat platforms, and information systems. Upon completion of the DAWE, the Chief of Staff of the Army (CSA) mandated that a proof-of-concept demonstration be conducted in the 2001 timeframe to affirm the progress of the key enhancement to the division, the operational and field components of the Army Battle Command System (ABCS). As such, TRADOC established the DCX in 1998 to serve as the capstone event for 4ID in 2001, with the goal to bring 4ID to a go-to-war status employing advanced capabilities. Additionally, the DCX provided the opportunity to glean insights that will help mature DTLOMS requirements, inform force structure and digital architecture decisions for the Army's future digitized units, and support the Army's effort in developing the future Objective Force.

The DCX analysis effort utilized both quantitative and qualitative techniques for evaluating the study issues and addressing the demonstration objectives for DCX. This report/briefing identifies the analysis approach undertaken, lessons learned from this process, and key results from the DCX analysis.

The Use Of Design Of Experiment During Tactics Development

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The events of 11 September will profoundly affect military affairs, at every level from strategic to operational to tactical. The fact is, all activities in a healthy military—including tactics, doctrine, weapons acquisition, joint operations, intelligence, and combat support—should be in a constant state of positive change. That is because the factors that affect military affairs are in a constant state of flux. These factors include changes in the threat's tactics and weapons, changes in the arenas in which we employ, and the emergence of new technologies creating potentially new capabilities in our weaponry. History, in fact, has shown that a failure to accommodate changes in the threat, the environment, and new technology leads to disastrous results in combat.

The emergence of a new level of international terrorism, especially as a direct and significant threat to the security of the continental US, is a perfect illustration of a factor that will demand changes in military tactics, doctrine, and weaponry. We should expect to see, therefore, changes in strategy, operational doctrine, tactics, and weapons over the near future. We may also see an increase in the funding for these endeavors. However, we can be sure that in any case, resources for testing will always be constrained. There will always be a need for efficient as well as effective testing.

All of the services have well established processes in place to develop new tactics in response to changes in the threat, the arena, and the available technology. In the Air Force, this process is most obvious during Tactics Development and Evaluations, or TD&Es. This form of operational testing typically involves operationally representative US platforms, employed by combat qualified crews, in realistic exercises, against representative live threats, capitalizing on digital computation for range support and weapon simulations. In fact, these exercises are run as close to combat realism as possible. For air-to-surface tactics, live ordnance is often employed. For air-to-air tactics, computer simulations substitute for live missiles and guns. Various tactics are proposed and then flown in these realistic scenarios. Results are collected in the form of both objective, quantitative data and subjective evaluations from the participants. Because the exercises are quite complex and involve many players and a large number of variables (some controllable, some not) affecting the outcome, and because the usefulness of tactics is often more opinion than fact, we have typically relied heavily upon the subjective post-mission assessments of the participants, and less on objective, quantitative analysis.

The use of Design of Experiment (DOE) as a methodology for setting up tests and evaluating the results has been essentially non-existent within Air Force tactics development. Even when offered to test managers, arguments against the use of DOE are many: DOE will overly constrain the participants in realistic, operational testing; the scenarios are overly complex for DOE; tactics are not suitable for numerical analysis; DOE demands too many resources. Recently, there has been a movement within the Air Force to utilize DOE during operational testing, though significant resistance remains.

The truth is, DOE has been used for many years on very complex experiments in the civilian sector. Its application to military experiments, including TD&Es, is clearly apparent. In fact, it is during the most complex kinds of experimentation, like tactics development, where DOE has the greatest potential to deliver more and better knowledge about the phenomena occurring, to provide quality answers using fewer resources, or to yield more information for the same resources. Nevertheless, we still face the same arguments.

The purpose of this study was to demonstrate the utility of DOE in the tactics development arena in order to dispel the myths that DOE is either impractical or ineffective. The study included both experimental design (for example, the use of factorial experiments, randomization, independent trials) and analysis (the use of ANOVA). The study utilized a Microsoft Excel-based simulation of aerial combat—a relatively simple, but nevertheless high fidelity model of aerial combat

engagements involving as many as 8 versus 8 players, using notional but realistic event probabilities obtained from subject matter experts. The model includes such events as threat detection, hostile declaration, and effective missile employment. After a significant amount of verification using subject matter expertise, the model was given favorable reviews. We then set up a notional tactics development evaluation, with a number of control factors typical of TD&Es (threat electronic warfare, friendly support assets, threat tactics options, and friendly rules of engagement) to assess two notional friendly tactics (Option A and Option B). Our response variables included such typical air-to-air success measures as kill ratios, threats killed, and friendlies lost.

The study used a series of engagement simulations to compare the results obtained using sound DOE principles against the most typical methodologies currently used: "one-factor-at-a-time" and "best guess." The study demonstrated the shortcomings of these techniques in comparison with both the efficiency and the effectiveness of results obtained through DOE.

By using an inexpensive, simple, but high fidelity simulation of aerial combat, we were able to demonstrate the value of DOE in the complex arena of tactics development. The fact is that in any tactics exercise, there are always constraints placed on the participants, generally in the control factors that we chose for our model (rules of engagement, friendly support, threat tactics, and so on). We have demonstrated that is possible to control the engagements at the scenario level, without constraining the maneuvering and tactical decisions of the participants. Using the scenario-level elements as our control factors, and by assessing results using traditional measures of effectiveness, we were able to demonstrate the utility of DOE in spite of the complexity of the experiment, thereby countering the traditional arguments against DOE. DOE was clearly able to provide more and better knowledge about the relationships between the control variables—especially the friendly tactics option—and the response variables, while using fewer trials that expend valuable test resources.

The result of this study is a method of demonstrating the utility of DOE during the most complex of tests, as the Air Force embarks on a program to make it the methodology of choice for all Air Force testing.

Experimentation within the C2 Operation Centers – The Design of a Quick-Draw Time Critical Targeting Team

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Twenty-first century warfare has mandated the gunfighter approach to finding and shooting targets. This means finding, fixing, tracking, targeting, engaging and assessing quickly, before the window of opportunity passes and the speed of decision assures the target no room for shelter. In JEFX 2000 we saw this mechanism paint a coherent picture of the battlespace and formulate C2 responses in a distributed environment. Based upon that picture we constructed a representative team, one-fifth the original size with detailed descriptions of missions, tasks, and informational flows. This structure will be required to manage larger and larger quantities of battlespace information but will do it more quickly in situations where individuals and teams can work out their battle rhythms. This will happen first in a laboratory-like environment which can train, test, assess and improve performance at both the individual and team level. This presentation will describe the assessment approach and methodology employed by the Air Force Research Laboratory's Warfighter Training Research Division (AFRL/HEA) researchers as they observed the C2 operators in the Time Critical Targeting Cell (TCTC) during JEFX 2000. The AFRL/HEA researchers followed a human-factors oriented approach to gain insight into the scope of issues confronting personnel in modern Air Operation Centers. These insights will ultimately drive the C2 operator training requirements and help characterize the individual and team "desired" performance capabilities.

Wireless Peer-to-Peer Limited Objective Experiment (WP2P LOE)

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Peer-to-Peer (P2P) collaboration technology is generating a lot in interest within DoD as a new paradigm for Command and Control. Advocates assert that P2P offers several apparent advantages over classical client-server collaboration that historically supports traditional hierarchical C2. This presentation will report on a Limited Objective Experiment (LOE)

conducted by the Joint Futures Laboratory at Joint Forces Command Joint Experimentation Directorate and the Naval Postgraduate School centered around the use of P2P applications running on hand-held and portable devices in a wireless network environment. We will highlight the issues of experiment design for the LOE and how the design flows from planning through to the results. In particular, we will describe the breakdown of the experimental objectives into pass/fail technology demonstration pieces and measurement/analysis pieces. The measurement/analysis pieces of the LOE include technical network operations, systems vulnerability analysis and cognitive measurements of situational awareness. Results will be presented.

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Joint Concept Development and Experimentation Project Alpha

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Project Alpha is a new yet parallel approach to joint concept development. Project Alpha is intended to be a good idea transfer agent. The goal is to bring in good ideas that have potential for revolutionary changes in DoD, and also evolutionary changes and enhancements to the current force. The difference in this new approach is that the focus is not only on inserting new ideas into the ongoing concept development process but to streamline the development of new ideas and get them out to potential stakeholders for development within their areas of expertise. Ideas will undergo a "rapid analysis process" and the product will be a streamlined way of getting the word out augmenting the formal DOTMLPF recommendations package.

Future Combat Systems (FCS) Command and Control (C2)

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As described in the Training and Doctrine Command's (TRADOC's) draft 24 January 2001 "The Objective Force Maneuver Unit of Action" Operations and Organization Plan, the elements that describe combat power are changing. Today combat power is defined as a linear function: the sum of maneuver, firepower, and protection multiplied by leadership. In the Future Combat Systems (FCS) equipped force, combat power becomes an exponential equation where the factors of maneuver, firepower, protection, and leadership are raised by the power of information.

This paper will describe the joint Defense Advanced Research Project Agency (DARPA) and U.S. Army Communication-Electronics Command (CECOM) Research and Development Center (RDEC) FCS C2 program, as well as the overall experimentation plan and the FSC C2 federation.

An Integrated Tool Suite for the Implementation of Computer-Based Experimentation in Support of EBO

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As the state of the practice of effects-based operations (EBO) continues to mature at an accelerated pace, computer-based experimentation will provide the only viable means of providing meaningful answers to many of the emerging questions. In this context, experiments must account for interactions between models representing an expanding collection of phenomenologically disparate disciplines. Empirical evidence suggests that interdisciplinary relationships are best implemented at the lowest level of aggregation as practicable. This presentation demonstrates a comprehensive, integrated tool suite for experimentation that can be effectively applied to the challenges of EBO.

Warfighting Experimentation WG-P1

Army MC02 Analysis

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As the lead for Army experimentation, the TRADOC Analysis Center has developed a comprehensive study plan and supporting analysis plans for the Army component of Millennium Challenge 02, Army Transformation Experiment 02. This presentation will present the overall methodology and highlights of these analysis plans as well as review how Army experimentation has evolved since 1997 and how we are applying lessons learned in MC02. The Army is in the process of accelerating its transformation to a capabilities-based organization with the intent of fielding the Objective Force by the end of this decade. The analysis during this experiment will inform senior leaders of the Army's contributions to Joint Operations and provide valuable insights to the Army's transformation pathway.

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as of: 20-May-02

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70th MORS Symposium Prospective Participants
as of: 20-May-02

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as of: 20-May-02

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as of: 20-May-02

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70th MORS Symposium Prospective Participants
as of: 20-May-02

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Alphabetical Index Of MORSS Presenters

Index

Index

Index

Index

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70TH MORSS AGENDA

US Army Combined Arms Center and Ft. Leavenworth

18 – 20 June 2002

Tuesday, 18 June 2002			
0700	0830	Registration (Bell Hall, Porch)	
0845	1645	Registration (Bell Hall – Room 4)	
0715	0815	CG/WG Chairs/Co-Chairs Warm-up Session (Bell Hall, Marshall Auditorium)	
0830	1000	**PLENARY SESSION** (Bell Hall, Eisenhower Auditorium)	
1030	1200	**1st**	WG Session
1215	1315	**Tutorials**	
1330 - 1500		**2nd**	WG Session
		A & B	COMPOSITE GROUP SESSIONS
1530	1700	**SPECIAL SESSION I**	
1715	1900	**Mixer** (Frontier Army Museum)	
Wednesday, 19 June 2002			
0700	0800	Town Hall Meeting (CG/WG Chairs only)/Editors' Breakfasts (FCC)	
0830 - 1000		**3rd**	WG Session
		C	COMPOSITE GROUP SESSION
1030 - 1200		**4th**	WG Session
		E	COMPOSITE GROUP SESSION
1215	1315	**Tutorials**	
1330 - 1500		**5th**	WG Session
		D & F	COMPOSITE GROUP SESSIONS (Please note: CG G will not have a Composite Group Session)
1530	1700	**SPECIAL SESSION II**	
1830	2200	*Steamboat Arabia Museum Dinner*	
Thursday, 20 June 2002			
0830	1000	**6th**	WG Session
1030	1200	**7th**	WG Session
1215	1315	**Tutorials**	
1330	1500	**8th**	WG Session
1530	1700	CG/WG Chairs and Co-Chairs Wrap-up (Bell Hall, Classroom 6)	
1530	1700	**SPECIAL SESSION III**	